SCIENCE TEACHER'S WORLD

Teacher's edition of Science World • January 20, 1959

Audio-visual aids in the science classroom

There is hardly a teacher of science who has not used slides, filmstrips, or motion-picture films in his teaching. There are certain ground rules that many teachers know but which are valuable enough to warrant reiteration. First, the class should know what to look for in the film. Second, questions and doubts should be taken care of during the projection of the film or as soon as it is finished. Third, the teacher should check to see whether the students found in the film the points they were searching for.

Many motion-picture films are packed so full of information that a single viewing will not suffice. Don't hesitate to show the film a second time. It is important that questions be asked in oral or written form to indicate to the student the ways in which the projected material fits into the class work. Showing a film, filmstrip, or slides without preparation or follow-up is frequently little more than a time filler.

If your school or your local school district or system has its own films, you are fortunate. Some states also have a film-lending unit for the schools. In addition, many large museums of science, as well as universities, have lending services. At the end of this article, you will find a list of film sources. You can write them for their latest catalogues. Industrial organizations produce excellent films, which are lent free (though you may have to pay postage).

If a teacher has not seen a film before, it is important that he preview the film. Also, if a teacher's guide accompanies the film, it should be read.

Frequently, you may want the students to see only a particular portion of the film. To show this portion, simply thread the projector up to the point where you want the film to begin, and stop the projector when you want the film to end. If the film covers a complete topic, it should be used as an introduction to that topic or as a summary after the topic has been studied. Usually, a film covers in from 12 to 20 minutes what might very well be a month's classwork. This puts the teacher more or less at the mercy of the sound track until the film is over. There is no way to pace the showing of the film to the class's ability to absorb the concepts developed in the film. This makes it difficult, if not almost impossible, for students to ask crucial questions until the film is over.

Many teachers prefer not to show films of experiments or demonstrations that they can perform in class. They prefer to show films of scientific developments that are too dangerous, too big, too expensive, or too intricate to demonstrate in the classroom. Audio-visual aids are particularly excellent for this purpose.

Since pacing is important to effective science teaching, many teachers prefer filmstrips or slides to motion pictures. Naturally, each medium has its own advantages. If motion is essential to the understanding of a concept, a motion picture is obviously superior. But the leisurely pace that filmstrips and slides permit, with an opportunity of discussing each frame, makes them more satisfactory to many science teachers. A filmstrip can be bought at about the cost of one film rental, and it will last five or more years. Filmstrip projectors are so inexpensive that each science room can have its own.

Classroom projection can be a routine operation, with students selected and trained in advance to operate the projector. This saves much class time and, more important, conserves that valuable commodity, "teacher energy." The way to do this is to train two boys from each class during free time or after school. Students are usually happy to do it. In some schools, an audio-visual squad is set up to operate all such equipment for the whole

January 20 issue ends first semester

Because of the end-of-term vacation period, the next issue of Science World will be dated February 10. It will reach schools on or before February 3, and is the first issue of the second semester.

If your classroom subscription is for the school year, the second semester's issues (starting with February 10) will, of course, reach you automatically. However, if you wish to revise the number of copies ordered we should appreciate hearing from you as soon as possible.

If your subscription is for one semester only, now is the time to renew, for this is the final issue of the first semester. If you wish, you may later revise the number of copies ordered. Naturally, you will be billed only on the basis of your final order. A prompt renewal guarantees uninterrupted delivery of SW to your classroom.

school. The simplest method for a single teacher, however, is to use students from whatever class the film will be shown to.

Some teachers and students make their own slides or motion pictures. The 2 x 2 inch color slides taken with a 35mm. camera are excellent. So are 8 or 16mm. motion pictures in color. If a teacher or student visits a place of scientific interest — a research laboratory, steel mill, etc. — he might well come back with pictures.

There are several types of homemade non-photographic slides that are very useful. These may be made in a few minutes. Ground glass or ground plastic slides can be used to draw diagrams and graphs, to print short tests, etc. An ordinary No. 2 lead pencil is all that is required. These blank slides are sold by audio-visual supply companies and by photographic supply houses. Ordinary tracing paper can be used in place of ground-glass slides, if the paper with its drawing is placed between two pieces of clear, slide-cover glass.

If you have or can borrow a Polaroid camera, black-and-white slide-film stock can be developed in one minute inside the camera. Another three minutes of preparation is required before mounting. Excellent slides can be made in this way. The film comes with plastic mounts and glass. Thus you can photograph pictures or charts or tables from a book without getting involved in developing.

For charts, quizzes, and other non-graphic material, you can buy a slide material that permits typing the information on a gelatin sheet. This is, in turn, bound between two slide-cover glasses. A homemade substitute for this can be made by using ordinary cellophane cut to the standard slide size of 3¼ x 4 inches. Against both sides of the cellophane section, place typewriter carbon paper so that the black waxed side is in contact with the cellophane. Slip these three layers into the typewriter, and type the information you wish to put on the slide. Then remove the carbon papers and place the cellophane, which carries the impression, between two slide-cover glasses. Bind the slide with slide-binding tape or Scotch Tape.

Some teachers set up student squads to make the slides. A suitable cabinet or filing system should be available for storing the slides. And an index should be kept. This becomes imperative when a large collection begins to accumulate. — Alexander Joseph

Distributors of films

Allis-Chalmers Mfg. Co., Advertising Dept., Milwaukee 1, Wis.

Almanac Films, Inc., 516 Fifth Ave., New York 18, N.Y.

American Can Co., 100 Park Ave., New York, N.Y.

American Cancer Society, 47 Beaver St., New York 4, N.Y.

American Film Registry, 24 E. 8 St., Chicago 5, Ill.

American Guernsey Cattle Club, 70 Main St., Peterborough, N.H.

American Museum of Natural History, 79 St. & Central Park West, New York, N.Y.

American Potash Inst., 1102 16 St. N.W., Washington, D.C.

Associated Bulb Growers of Holland, 29 Broadway, New York, N.Y.

Associations Films, Inc., 347 Madison Ave., New York 17, N.Y.

Athena Films, Inc., 165 W. 46 St., New York 19, N.Y.

Audio Productions, Inc., 630 Ninth Ave., New York 19, N.Y.

Australian News & Information Bureau, 636 Fifth Ave., New York 20, N.Y.

Bailey Films, Inc., 6509 De Longpre Ave., Hollywood 29, Calif.

Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N.Y.

Beet Sugar Development Foundation, P.O. Box 531, Fort Collins, Colo.

Stanley Bowmar Co., 513 W. 166 St., New York 32, N.Y.

Brandon Films, Inc., 200 W. 57 St., New York 19, N.Y.

Bray Studios, 729 Seventh Ave., New York 19, N.Y.

Bureau of Communication Research, 13 E. 37 St., New York 16, N.Y.

J. I. Case & Co., Inc., Racine, Wis.

Coronet Films, Coronet Building, Chicago 1, Ill.

William Cox Enterprises, 2900 S. Sawtelle Blvd., Los Angeles 24, Calif.

De Kalb Agricultural Assn., Educational Div., De Kalb, Ill.

Denover-Geppert Co., 5235 N. Ravenswood Ave., Chicago 40, Ill.

Dow Chemical Co., Advertising Dept., Midland, Mich.

Edited Pictures System, Inc., 165 W. 46 St., New York 19, N.Y.

Encyclopaedia Britannica Films, Inc., 1150 Wilmette Ave., Wilmette, Ill.

Ethyl Corp., Chrysler Bldg., New York 17, N.Y.

General Electric Co., Advertising & Sales Promotion Div., Schenectady, N.Y.

General Motors, Dept. of Public Relations, 3044 Grand Blvd., Detroit 2, Mich.

Hawaii Press Bureau, 1040 Natl. Press Bldg., Washington 4, D.C.

Hy-Line Poultry Farms, 1206 Mulberry St., Des Moines 9, Iowa

Ideal Pictures Corp., 58 E. South Water St., Chicago 1, Ill.

Institute of Visual Training, 40 E. 49 St., New York 17, N.Y.

Institutional Cinema Service, Inc., 165 W. 46 St., New York, N.Y.

International Film Bureau, Inc., 57 E. Jackson Blvd., Chicago, Ill.

State University of Iowa, Bureau of Visual Instructions, Iowa City, Iowa

Kansas State College, Dept. of Poultry Husbandry, Manhattan, Kan.

Knowledge Builders, 625 Madison Ave., New York 22, N.Y.

Lederle Laboratories, Div. of American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N.Y.

Library Films, Inc., 25 W. 45 St., New York 19, N.Y.

Metropolitan Life Insurance Co., 1 Madison Ave., New York 10, N.Y.

Milk Industry Foundation, Chrysler Bldg., New York 17, N.Y.

Modern Talking Picture Service, Inc., 45 Rockefeller Plaza, New York 20, N.Y.

National Audubon Society, 1130 Fifth Ave., New York, N.Y.

National Fertilizer Assn., 616 Investment Bldg., Washington 5, D.C.

National Film Board of Canada, 630 Fifth Ave., New York 20, N.Y.

National Garden Bureau, 407 S. Dearborn St., Chicago, Ill.

National Tuberculosis Assn., 1790 Broadway, New York 19, N.Y.

N.Y. Times, Office of Educational Activities, 229 W. 43 St., New York 36, N.Y.

North Carolina State College, Dept. of Visual Aids, Raleigh, N.C.

Ohio State University, Dept. of Photography, Columbus 10, Ohio

Samuel Orleans & Associates, Inc., 211 W. Cumberland Ave., Knoxville 15, Tenn.

Skibo Productions, Inc., 165 W. 46 St., New York 19, N.Y.

Society for Visual Education, Inc., 1345 W. Diversey Parkway, Chicago 14, Ill.

Sugar Information, Inc., Sugar Research Foundation, 52 Wall St., New York 5, N.Y.

Swift and Co., Public Relations Dept., Union Stock Yards, Chicago 9, Ill.

Teaching Films Custodians, Inc., 25 W. 43 St., New York 18, N.Y.

U.S. Dept. of Agriculture, Washington, D.C.

U.S. Public Health Service, Communicable Disease Center, Atlanta, Ga.

United World Films, Inc., 1445 Park Ave., New York 29, N.Y.

University of California, University Extension, Visual Dept., 2272 Union St., Berkeley, Calif.

Visual Education Consultants, 2066 Helena St., Madison 4, Wis.

Ward's Natural Science Establishment, 3000 East Ridge Road, Rochester 7, N.Y.

West Coast Lumberman's Assn., 1410 Southwest Morrison St., Portland 5, Ore.

Westinghouse Electric Corp., School Service, 306 Fourth Ave., P.O. Box 1017, Pittsburgh 30, Pa.

Wilner Films & Slides, P.O. Box 231, Cathedral Station, New York 25, N.Y.

Wisconsin Alumni Research Foundation, P.O. Box 2059, Madison, Wis.

Wistar Institute, 36 St. and Woodland Ave., Philadelphia, Pa.

Wool Bureau, Inc., 16 W. 46 St., New York 19, N.Y.

Young American Films, Inc., 18 E. 41 St., New York 17, N.Y.

MEMO

To: Science teachers

Subject: Ways to use this issue of SCIENCE WORLD in the classroom

Benjamin Franklin

PHYSICS TOPICS: static electricity; the Leyden jar; conservation of charge
GENERAL SCIENCE TOPIC: what causes lightning?

All too infrequently does the science teacher go out of his way to give the social setting and the historical background of a scientific discovery. Rose Wyler's article gives the teacher an opportunity to do so. Moreover, the article associates a fundamental area of modern physical science with one of the founding fathers of our republic. Most students know about Franklin's "drawing fire from the clouds." But few appreciate the fact that Franklin was a great theoretician who developed concepts of electricity that have endured to the present time. Here are some activities that will supplement the article, allowing a pupil to see for himself some effects of electric charge:

- Stroke a hard rubber surface, such as a fountain pen or a comb, against woolen clothing. Immediately move the object near some bits of paper. The paper will be attracted.
- Rub an inflated balloon against woolen clothing. Place the balloon against a wall or ceiling. The balloon will stick to the surface until the charge escapes.
- Place a single sheet of newspaper against a blackboard or wall. "Massage" the newspaper with your hand. The paper will stick to the wall until the charge escapes into the air.
- Adjust a faucet so that a thin stream of water flows from it. Now rub a hard rubber fountain pen or a comb over wool and hold it near the stream of water. The stream will be deflected.
- Cut a piece of newspaper about 20 inches long and 3 inches wide. Fold it into a V. Use a ruler or a wooden pencil to suspend the paper so that the ribbons of paper hang down. Insert the index finger between the paper strips, with the thumb and middle finger of the same hand on the outside surfaces of the strips. In this way, stroke the paper several times, from top to bottom. The ends of the paper will move apart and remain apart until the charge escapes.
- Comb your hair (dry) in a dark room near a mirror. Observe electric sparks.
- Scuff your feet against a rug in a dark room. Then touch a metal doorknob and observe the electric spark.
- Connect bell wires to the terminals of one or more batteries. Touch the ends of the wire and move them apart. Observe the electric spark.
- Try the stunt described in "Unpepper the Salt," page 26.

Questions to investigate

1. Why does a gasoline truck have a dangling chain?
2. What device is used on your school mimeograph machine to prevent the papers from sticking together?
3. Suppose a bottle of ether was left unstoppered in an electric refrigerator in a laboratory. Ether is highly inflammable. During the night there was a terrific explosion. What caused it?

Rocket and missile quiz

Covers a wide variety of topics in physics, chemistry, earth science, and general science.

Any science teacher who ignores in his teaching the strong current interest in rockets and space travel is missing an opportunity to utilize a powerful motivation and a fertile area of applications of scientific principles. The alert physics teacher, for example, will find in this quiz questions to which he can refer when the class is studying Newton's laws of motion (including momentum and angular acceleration), infra-red radiation, air resistance, gravitation, absorption of radiant energy, and short-wave radio transmission. And the chemistry teacher can, among other things, refer to a unique application of ions and ionization. The quiz might well be used in conjunction with Jules Bergman's article, "Countdown at Cape Canaveral" (see p. 4-T).

The science of language

BIOLOGY TOPICS: organs of speech; nervous system (brain)
PHYSICS TOPICS: how sounds are formed; the sound spectrograph; the voice typewriter
GENERAL SCIENCE TOPIC: communication

Do you know that the Arabic language contains some 6,000 words referring to camels and camel equipment? That many of the world's 5,000 languages have no alphabet? That there is a typewriter that takes dictation and types as words are spoken? These are some of the intriguing facts contained in this article. Problems of human communication did not begin or end with the Tower of Babel, nor are they solved by such modern devices as radio and television. The solutions will require applications of all available resources of the natural and social sciences. The article defines some of these problems and indicates some beginnings that have been made toward their solution.

Questions

1. What parts of a human body are

If they can't go to college– What then?

It is a matter of record that tens of thousands of our high school youth, today, who have the intellectual capacity to complete college are financially unable to attend. This situation must present, at times, a frustration to teachers and guidance counsellors to whom students look for advice. In such cases, an Air Force enlistment offers this three-fold solution.

First: With the vast advances being made in the Air Force in rocketry, jet propulsion, electronics, aerodynamics and other specialties allied to the new Age of Space, participation in an Air Force training program is tantamount, in some respects, to scientific instruction at university level. The schooled and experienced Air Force technician represents, on the average, an $18,000 investment in professional competence.

Second: In conjunction with the United States Armed Forces Institute and cooperating universities, the Air Force affords its personnel the opportunity during off-duty time to take courses leading to an academic degree –either on-base or by correspondence –part of the cost of which may be borne by the Air Force. The Airman may also be assigned, on a temporary duty basis, with full pay and allowances, to complete his final semester at the college of his choice.

Third: Qualified Airmen may apply for Officer Candidate School, the Aviation Cadet Program, or the Air Force Academy.

In summary: if a student is able to attend college, the Air Force believes he should. If he cannot, the Air Force believes that it provides a highly satisfactory alternative of educational experiences.

Teachers and Guidance Counsellors who are interested in learning more about Air Force opportunities for their students may receive a catalogue of informational materials (booklets, brochures and films) by writing: Educators' Information, Dept. STW-1, P.O. Box 7608, Washington 4, D.C.

involved in speech?

2. What is a phoneme?
3. Can you describe the "whistle language" of natives of the Canary Islands?
4. What does the term "bush telegraph" refer to?
5. How do bees "talk"?
6. In answer to the question, "What is the relationship between language and culture?" present two opposing theories proposed by anthropologists.

Students interested in learning more about the science of language may wish to see the hour-long TV program on which this article is based. Called "The Alphabet Conspiracy," the program is the newest in the Bell Science Series. It will be telecast over the NBC television network on Monday, January 26. Check your local listings for the time the program will be seen in your part of the country.

A film of this program will be available on loan to schools without charge. Get in touch with your local Bell Telephone Business Office for further information.

Plants and animals, Inc.

BIOLOGY TOPICS: symbiosis; microscopy; nutrition; behavior; ecology; evolution; conservation

Symbiosis is the subject of this article. Many examples of the mutual dependance of living things are given — sponge and crab, alga and fungus, plant and bacterium, protozoan and insect, and even bird and mammal. The biology teacher will find material that can enrich his teaching of any of the units listed above. He can also stimulate students to undertake interesting projects. For example:

1. Collect plants belonging to the pea family (clover is the most common). Wash the roots and remove the nodules. Add a drop of water to the nodules and crush them between two microscope slides. Under a microscope, look for the nitrogen-fixing bacteria. For a sharper view of the bacteria, smear the liquid crushed out of the nodules onto a clean slide. Let it dry. Pass the slide through a flame to cause the bacteria to stick to the surface of the slide. Place several drops of a stain such as methylene blue on the smear and, after a minute, wash off with water. Then examine the stained bacteria.
2. Collect lichens. Place a piece of lichen in a drop of water on a microscope slide. Shred the lichen into fine pieces and examine it under a microscope to see the alga cells and the branches of the fungus.

3. If you live in the vicinity of shallow sea water, look for "moving" shells. Put them into a dish of sea water. They may turn out to be snails. On the other hand, you may find a shell with a "tenant" in it — the hermit crab. If so, pull it out of the shell and examine its body. Also, examine the surface of the shell to see whether living organisms are attached to the outside.

Countdown at Cape Canaveral

CHEMISTRY TOPIC: liquid oxygen
PHYSICS TOPICS: Newton's laws; gravitation; radar; automation
GENERAL SCIENCE TOPICS: space exploration; rockets; weather; astronomy

This "you-are-there" account of a rocket launching captures the excitement of a dramatic event. And it offers a superb example of the most sophisticated physics, chemistry, and mathematics of our time being applied to a device that gives promise of opening up new horizons to mankind.

Discussion questions

1. Why is a rocket launched from a vertical position?
2. Why is there an interval between the time the rocket is fired and the time it leaves the ground?
3. Why is liquid oxygen pumped into the rocket until almost firing time?
4. Define each of the following terms applied to rockets and rocket firings:

   blast-off
   hold
   LOX
   launching pad
   countdown
   umbilical cord
   bird
   blockhouse
   telemetry

5. Other questions on rocketry may be found in "Rocket and Missile Quiz," page 12.

JANUARY 20, 1959

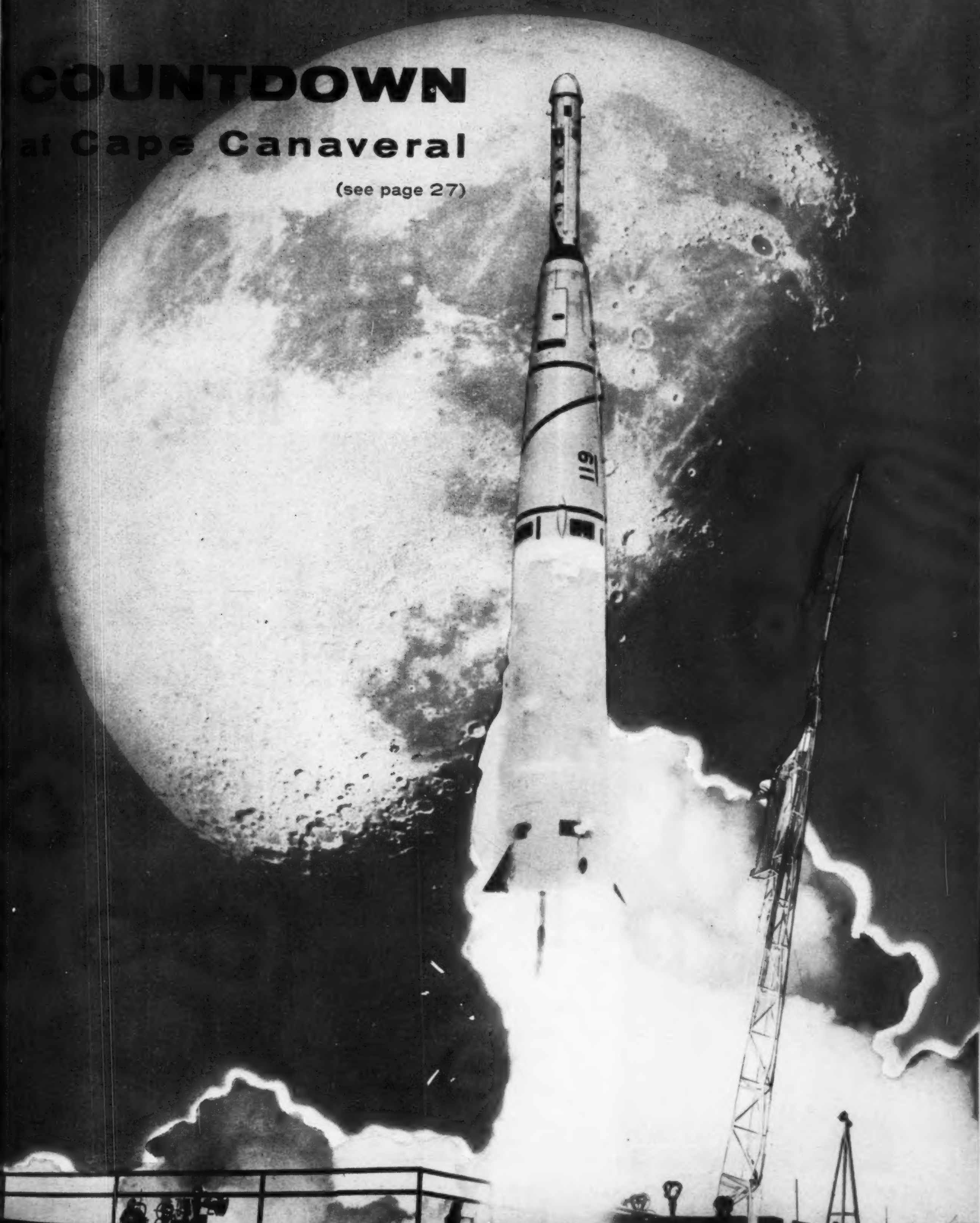
SCIENCE WORLD

THE SCIENCE MAGAZINE FOR HIGH SCHOOL STUDENTS

COUNTDOWN

at Cape Canaveral

(see page 27)



SCIENCE WORLD is published biweekly during the school year, September through May inclusive (8 issues per semester, 16 issues per school year), except during school holidays and at mid-term by

SCIENCE WORLD is published biweekly during the school year, September through May inclusive (8 issues per semester, 16 issues per school year), except during school holidays and at mid-term by Street & Smith Publications, Inc., 575 Madison Avenue, New York 22, N.Y. Second-class postage paid at New York, N.Y., and at additional mailing offices. © 1959 by Street & Smith Publications, Inc., in the United States. Subscriptions, U.S.: $1.00 per semester (8 issues); two-semester subscription (16 issues), $1.50; single copy, 15¢. Back copies, 25¢. Canadian subscription rates are the the same as United States; additional postage for countries in Pan American Union: one semester, $1.00, two semesters, $2.00; cost of additional postage for other foreign countries: one semester, $1.50, two semesters, $3.00. Address all subscription mail to Science World, 304 East 45 Street, New York 17, N.Y. Send notice of undelivered copies on form 3579 to: Science World, McCall Street, Dayton 1, Ohio.
Printed in U.S.A. 24

SCIENCE WORLD

THE SCIENCE MAGAZINE FOR HIGH SCHOOL STUDENTS

The Staff

Editor-in-Chief: Patricia G. Lauber
Managing Editor: Roger G. Menges
Art Director: Murray J. Miller
Copy Editor: Marguerite S. Hecking
Library/Research: Harriet E. Rosenfeld
Assistant Editor: Jane Rockwell
Editorial Assistants: Julio E. Xavier, Zelda Gilbert

Consulting Editor: Dr. Morris Meister,
Past Principal and Founder, Bronx High School of Science

Contributing Editors
SCIENCE WORLD:
Edmund H. Harvey Jr.
SCIENCE TEACHER'S WORLD:
Dr. Alexander Joseph, Bronx High School of Science
Dr. Zachariah Subarsky, Bronx High School of Science

Street & Smith Publications, Inc.
Also publishers of Mademoiselle, Living for Young Homemakers, Charm, Astounding Science Fiction, American Modeler, Air Progress, Air Trails Model Annual

President: Arthur Z. Gray
Executive Assistant to the President: Irma Pezzia Haubold
Executive Vice-President: Ralph R. Whittaker Jr.
Vice-President and Advertising Director: Robert E. Park
Treasurer: Thomas H. Kaiser
Director of Sales Development: Edward M. McGlynn

Advertising Manager: Ernest E. Pascucci
575 Madison Ave., New York 22, N. Y.
Western Manager: Glover M. Young
230 N. Michigan Ave., Chicago 1, Ill.
Los Angeles Representative: Whaley-Simpson Co.
6608 Selma Ave., Los Angeles 28, Calif.
San Francisco Representative: Whaley-Simpson Co.
700 Montgomery St., San Francisco, Calif.

Publication Office: 575 Madison Avenue, New York 22, N. Y.

Contents • January 20, 1959 • Vol. 4 • No. 8

Features

Stranger Than Fiction

Departments

Cover, official U.S. Air Force photos

Coming in SW, February 10

With what event will the era of manned space flight begin? When will it take place, and who will be involved?

What is the difference between weight and mass? Why do scientists need to know the mass of an object?

How are plastics made?

By what two methods are vaccines cultured for medical use?

For answers, see next issue of *SW*.

Next issue: February 10

Because of the end of the first semester, the next issue of SCIENCE WORLD will be dated February 10. It will reach you on or before February 3.

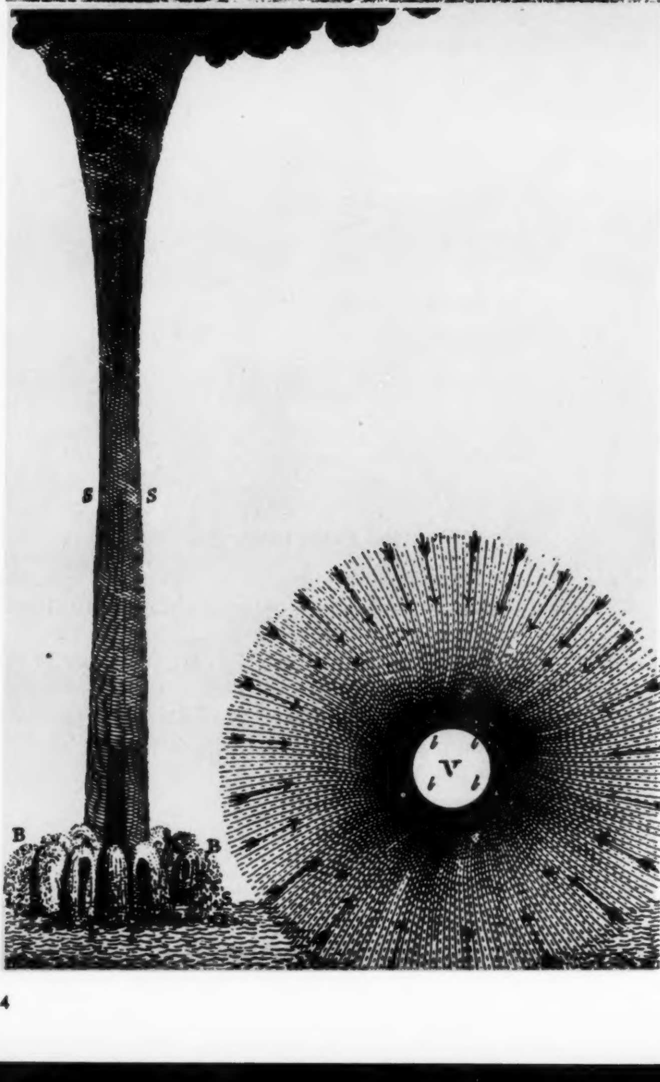
However, this issue (January 20) is the last of the first semester. If your subscription is for the school year, then SCIENCE WORLD will continue to reach you automatically. But if you are a one-semester subscriber, now is the time to renew.

Renewal subscriptions should be sent to:

Science World Subscription Department
304 East 45th Street
New York 17, N. Y.

A one-semester subscription (eight issues) to *SW* costs only one dollar.

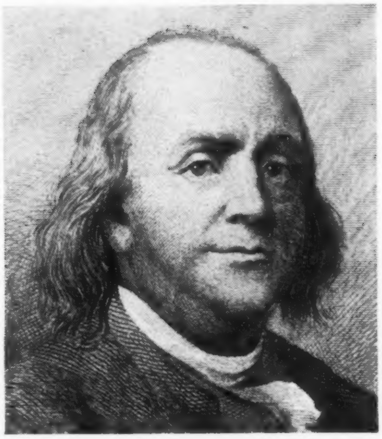
— Bettman Archive



Franklin's famous kite experiment proved that lightning was electrical in nature. Franklin flew the kite into a thunderhead. A pointed wire on the kite drew an electrical charge from the lightning. Electricity flowed down the wet (from the rain) kite string to a metal key. From the key streamed sparks — in Franklin's words, 'electric fire.' (The above drawing, like others illustrating the event, is full of inaccuracies.) The kite experiment was but one of Franklin's scientific contributions. He even delved into meteorology. He originated the idea of high and low pressure areas in the atmosphere and explained the water spout in terms that still hold up today. The diagram at left is one Franklin drew to show the way warm air is pushed upward by cooler, heavier air from surrounding areas.

— Drawing from Benjamin Franklin's "Experiments and Observations on Electricity Made at Philadelphic in America"

— Visual Discoveries



PATRIOT SCIENTIST

By Rose Wyler

■ Of all American success stories, the best-known is that of Benjamin Franklin, born 253 years ago this January 17. His witty and wise autobiography continues to be one of the most widely read books in the English language. But, curiously enough, one fascinating part of the story of his rise from Boston rags to Philadelphia riches is often overlooked. This is Franklin's work as a scientist.

In his own time, Franklin was considered one of the outstanding, if not the greatest of, living scientists. Here and abroad he was known as the inventor of many important devices. Among them were the lightning rod and the open (or "Franklin") stove, the most efficient stove of the day. Franklin was also regarded as a great organizer of scientific institutions. He led the campaigns to establish the colonies' first hospital, the first college modeled along modern lines (now the University of Pennsylvania), and the first research society, the American Philosophical Society.

More important, from the public's point of view, was Franklin's work in the field of electricity. His spectacular kite experiment, proving "the sameness of lightning with electricity," won him fame throughout Europe. Even British scholars, who tended to look down on "colonials," were impressed. They hailed Franklin as the American Newton and bestowed upon him their highest scientific honor, the Copley Medal.

In 1753, when the award was made, home-rule movements were growing in the colonies. A new governor for Pennsylvania, Captain Denny, had just been appointed. He was instructed to present the Copley Medal on his arrival and to use the occasion to bribe Franklin. The Governor suggested that the distinguished Assemblyman would find it extremely profitable if he would use his influence to win support for the Proprietors of the colony. Franklin, the clever politician, was impressed. But instead of accepting, he decided to turn the tables and use his influence on Denny. He was so successful that the Proprietors soon became distrustful of their appointee.

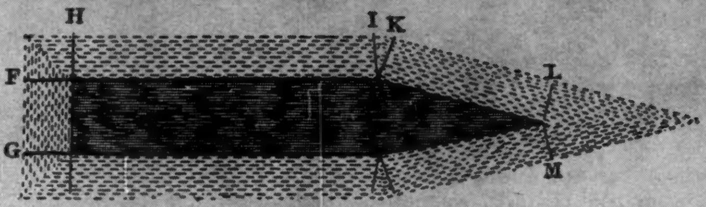
First scientific ambassador

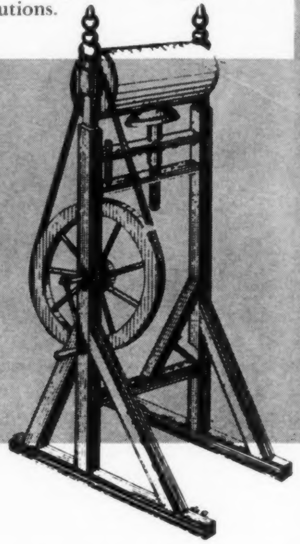
A few years later, Franklin was sent abroad to plead the case of the colonies. For five years, from 1757-62, he served as an American agent in England — and served shrewdly. When negotiations were impossible, he spread good will by giving lectures and demonstrations on electricity. He thus became a scientific ambassador — the first in the world. Gaining audiences that could never have been reached by a politician, he eventually succeeded in wringing desired concessions from the Crown.

In 1764, when the Stamp Act was being prepared, Franklin went to England again. He tried to prevent the passage of the Act. Failing in his mission, he went to England's foremost rival, France, where he made important contacts.

The contacts were put to good use in 1776, when Franklin went back to France to solicit funds for the new United States of America. Wherever he went, crowds rushed to greet him. Cheers went up when Voltaire, the greatest savant of the Old World, embraced Franklin, the greatest savant of the New World. Louis XVI and his queen, Marie Antoinette, also feted the republican scientist, although they were hesitant to give support to the revolutionary government that he represented. Their wavering ended when news reached Paris that the British General Burgoyne had surrendered his armies. At this point, Franklin finally won over the French Court and obtained recognition, as well as military aid, for his country.

Franklin's greatest work was still to come. After negotiating and signing the peace treaty, he returned home and helped frame the Constitution. Franklin was by then





Franklin proposed that a sentry box (*his drawing, left*) be placed on top of a high tower to prove the electrical nature of lightning. Taking Franklin's suggestion, a French scientist tried a similar experiment, which was successful. Another of Franklin's drawings (*below, left*) is an illustration of his theory explaining why an electric charge jumps from the point of a charged object. In his electrical experiments, Franklin used an electrostatic machine (*below*). His experimental approach remains one of his greatest contributions.

— Illustration of electrostatic machine from New York Public Library picture collection, others from "Experiments and Observations"

eighty-three years old, but still vigorous. Since his sight was failing, he was able to use one of his own inventions — a pair of bifocals.

It was no accident that Franklin became both a patriot and a scientist. In Boston and, later, in Philadelphia, he had read the advanced ideas that were coming from England and France. These influences of the Age of Enlightenment helped make him a revolutionary in politics and an innovator in science.

Ever since his youth, Franklin had read widely in natural philosophy, as science was then called. But his systematic experimental work did not begin until he was middle-aged and had retired from business. On hearing that some fine electrical equipment was for sale, Franklin bought it and set up a laboratory. Perhaps if some other type of material had come to his attention, he would have bought that and worked in some other field. It was the exploration of the unknown, rather than electricity itself, that Franklin found highly challenging.

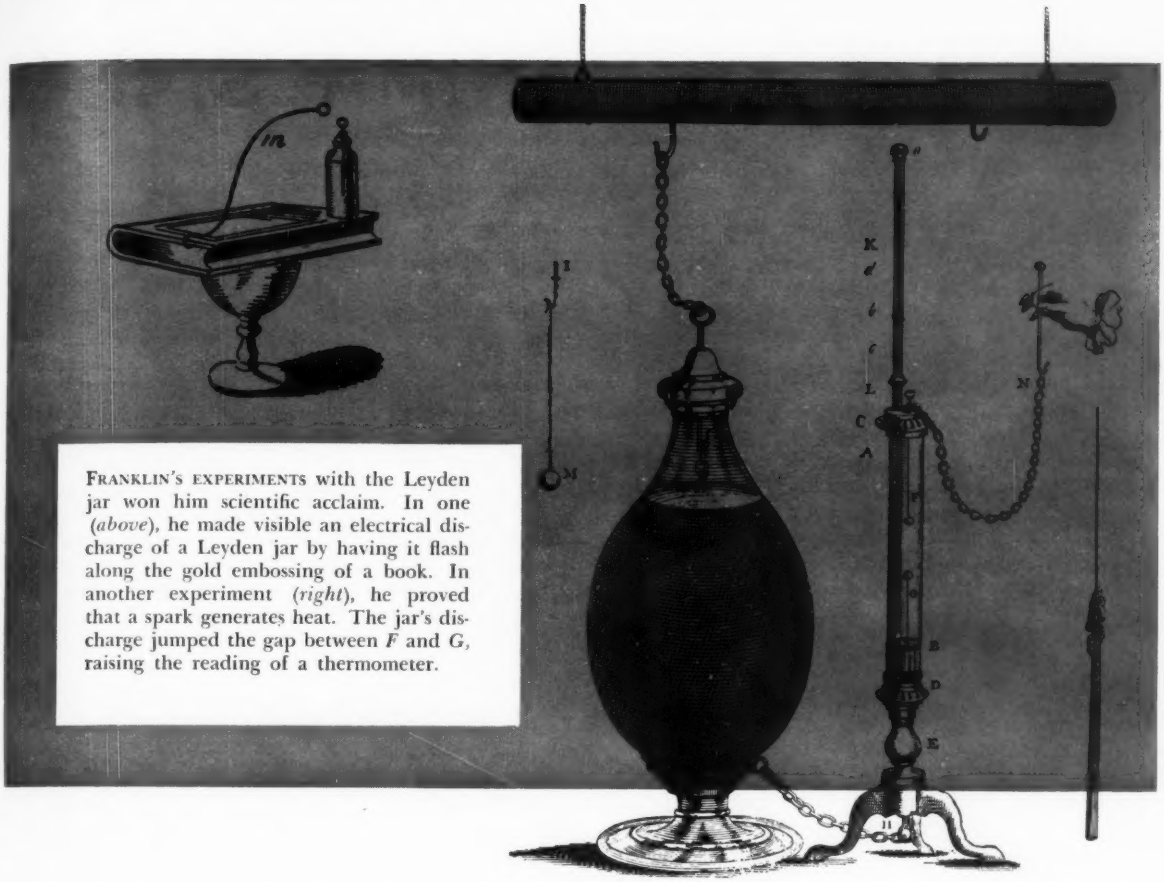
Franklin proved to be an ingenious experimenter. He soon found out that electricity was not made by friction, as most people had thought. To explain its behavior, he developed the theory that an "electrical fluid" is present in all things. Normally, each object contains a certain amount of fluid, he theorized, but when an object is "electrified," or "charged," its quantity of fluid is either increased or decreased. In the former case, Franklin called the charge "positive," or "plus"; in the latter case, he referred to it as a "minus," or "negative," charge. This was the first use of these terms, which are now standard.

Franklin also originated several other words such as battery, condenser, conductor, discharge, armature, electric shock, and electrician. In fact, most of his experiments were so original that he had to develop a whole new vocabulary to describe and explain them.

Franklin's study of the effect of electricity on pointed objects was the first of its kind. These objects interested him, he said, because they had the power of "drawing off and throwing off" charges. Through a series of simple experiments, he discovered that if a needle is brought near a charged, insulated body, it draws off the charge, provided the needle is grounded. But if the needle has been covered by an insulator, it does not remove the charge. Franklin also learned that a pointed metal object cannot be charged, for the charge is thrown off as fast as it is applied.

These findings might have seemed trivial to a lesser mind, but Franklin foresaw a use for them. He, as well as many others, suspected that lightning was an electrical discharge, though there was no proof of this. If proof could be found, he would then set up a large pointed conductor rising from the ground. This rod would draw lightning from the sky and safely lead it into the earth.

To find out whether lightning



Franklin's experiments with the Leyden jar won him scientific acclaim. In one (*above*), he made visible an electrical discharge of a Leyden jar by having it flash along the gold embossing of a book. In another experiment (*right*), he proved that a spark generates heat. The jar's discharge jumped the gap between *F* and *G*, raising the reading of a thermometer.

was electrical in nature, Franklin considered placing a booth on top of a tall steeple. Inside, there would be a dry, insulated platform with an iron rod rising from it. The rod was to lead through the door of the booth and then extend upward 20 to 30 feet. If a man were to stand on the platform during a storm, he might, as Franklin said, "be electrified and afford sparks, the rod drawing fire from a cloud."

Franklin himself wanted to be the man in the experiment. He planned to use a high steeple that was being built on a local church. Meanwhile, he wrote a detailed account of his plan, which he sent to a friend in England. The friend published it, along with several other Franklin papers, in a book entitled, *Experiments and Observations on Electricity Made at Philadelphia in America.*

Shortly afterward, Franklin thought of using a kite for the experiment. When a storm came up, he and his son flew a kite into a thunderhead. A metal key dangled from the kite string. Sparks flashed from the key, just as Franklin had predicted. Along with the sparks were crackling sounds, which were like miniature thunderbolts. There could be no doubt, concluded Franklin, that lightning was nothing more than a gigantic electric spark.

A few months later, Franklin learned he was not the first to prove this important point. His book on electricity had been sent to France. Monsieur Dalibard, who had translated it, had tried the experiment from a booth placed on the ground. News that sparks leaped from the iron rod in the experiment created a sensation. The king requested a special performance, and soon crowds were flocking to electrical demonstrations. All over Europe, people were talking about Franklin as though he were a magician who had tamed lightning.

Impressive as it was, Franklin's study of lightning was not his major scientific work. From another series of experiments, he found out how one type of condenser, the Leyden jar, works. He also made the discovery that electricity can only be redistributed; it cannot be created or destroyed. This is the law of conservation of charge. Franklin even anticipated the modern electron theory. Since electricity could penetrate metals as easily as a gas spreads through air, he reasoned it must be made of "subtile particles."

A new era of electrical research was started by Franklin's work, for it drew attention to the importance of measuring charges. His one-fluid theory emphasized the basic similarity of all electrical phenomena and provided a working hypothesis that stimulated further experimentation.

Franklin's contributions to the field of electricity cannot be overestimated. Had he never become famous as an American patriot, he still would have an honored place in history. For Franklin was America's first great scientist — and one of the world's true greats.

PLANTS AND ANIMALS, INC.

Unusual partnerships have been discovered among living things.

Dwelling together, they provide one another with the necessities of life

By Roy A. Gallant

■ Like man, many other members of the animal world are gregarious creatures. They live together in animal societies, receiving mutual benefits in the form of protection against enemies, of more effective food gathering, and so forth. Surprisingly few animals live alone. Many plants live in "partnerships," too.

Botanists and zoologists have long been interested in this biological "togetherness," particularly when two animals of different species, or a plant and an animal, live in a very close partnership. The relationship of two such organisms living together with mutual benefit is called symbiosis. If you know what to look for, you can observe these biological partnerships in your own back yard. And if your curiosity is strong enough, you can set up a home laboratory for the study of symbiosis. The following are examples of animal-animal, plant-plant, and plant-animal symbiosis. In some cases each "partner" could not survive without the other; but in other cases the two

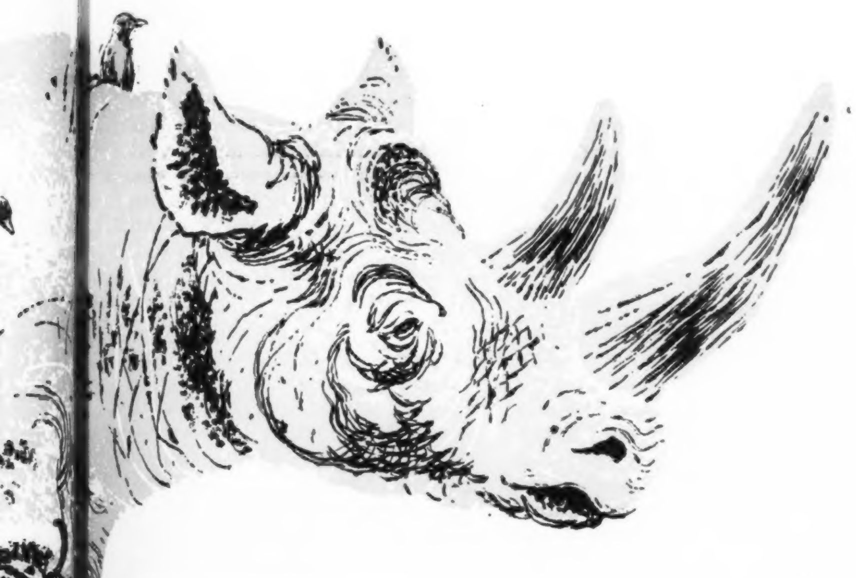
simply have a better chance of surviving when they live together.

Termites: These insects, which resemble ants, can be troublemakers if they set up housekeeping in the beams and rafters of your home. Because termites avoid exposure to dry air, you rarely see them. They spend nearly all of their time in a vast network of tunnels, created as they eat their way through wood. Their food is the cellulose contained in wood. Cellulose is a complex carbohydrate that few animals are able to use as food. Even termites cannot digest cellulose all by themselves.

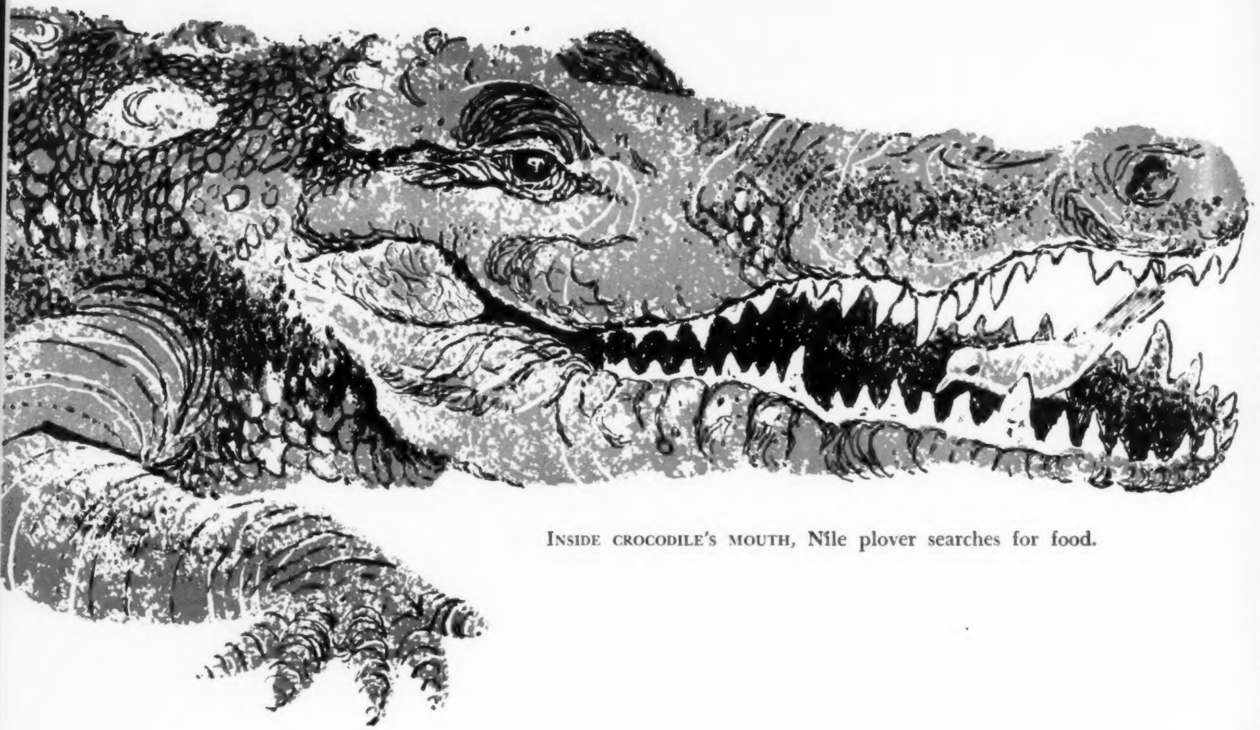
The cellulose is digested by a species of protozoans that live in the termite's intestines. The protozoans turn the cellulose into sugar. The sugar supplies energy not only for the protozoans, but also for their host. If all the protozoans in a termite die, the insect goes right on eating its way through a rafter. But because the termite can no longer digest cellulose, it soon starves to death. In this example of symbiosis, then, the wood eaten by the termite provides the protozoans with their food, while the wood digested by the protozoans provides food that the termite can digest.

Lichens: At one time or another, nearly all of us have seen lichens. They are extremely hardy plants that come in a variety of colors. They grow on bare rocks, on sunbaked brick walls, and even in the cold of Siberia. While some of them are scale-like, others resemble moss, and still others give the appearance of long, tangled masses of thread. If you examine lichens under a microscope, you will find that they are not one plant but two different kinds of plants living symbiotically.

One part of the lichen plant consists of a fungus. The other part is made up of one-celled plants called algae. Blotter-like, the fungus retains moisture, which is used by its alga partner. Because the green algae have chlorophyll, they are able to combine the water with carbon dioxide from the air and manufacture food. This food is used by themselves and by the fungus. As generations of lichens live and die, organic and mineral materials are deposited on rocks. This enables higher plants to grow among the lichens. Eventually, through the growth and death of



PICKING TICKS from an African rhinoceros' skin, tick birds get food, at the same time rid animal of annoying parasites. Birds also act as sentinels for nearsighted rhinos, chirping loudly when danger approaches. *Right:* cross section of lichen shows algal cells (dark bodies) and hyphae threads of fungus 'partner.'



Inside crocodile's mouth, Nile plover searches for food.

the higher plants and lichens, soil is formed on the rocks.

In this example of symbiosis in plants, the algae provide the fungus with food, while the fungus provides the algae with water, shelter, anchorage, and protection. Although the algae can sometimes live by themselves, they do better when living symbiotically with fungi.

Sponge and crabs: One of the most striking examples of symbiosis between two animals is found in the sponge-crab partnership. Hermit crabs are known to occupy empty sea shells, particularly snail shells. The shells serve as a kind of protective fort. Eventually, a sponge may attach itself to such a shell and grow completely around it, except for a hole through which the crab can extend the front part of its body. In time, the sponge destroys the shell, but it does not destroy the crab. The crab remains intact, living in a cavity within the sponge. In this way, the sponge provides the crab with more protection than the crab's shell alone can give. And the crab provides the sponge with transportation. This apparently enables the sponge to gather more food than it could if it remained attached to a rock.

Sometimes, plant-like animals known as hydroids attach themselves to the top of the shell and to the exposed claws of the crab. As the crab moves around, the hydroids are given free and effortless transportation to sources of food. Also, food dropped by the crab or left over from its meal becomes food for the hydroids. The crab gains by the relationship, too. The hydroids sting enemies of the crab and provide the crab's snail house with protective coloration. Though the crab and the hydroid are each capable of living independently, their chances of survival seem better in symbiosis.

Ant "cows": Aphids, commonly known as plant lice, are a farm and garden pest. You often find them on plants. They feed on the juices of plants and so stunt the plant's growth or kill it.

One aphid, called the corn-root aphid, lives underground. It feeds on the roots of corn plants and is regarded by farmers as a pest. The aphid lives in symbiosis with certain ants. The ants find corn-root aphids in grass or weeds. The ants carry the soft-bodied aphids underground through tunnels and place them on the succulent corn roots. Here the aphids dine on their favorite food throughout the summer. Meanwhile, the ants protect the aphids from their enemies. When winter comes, the ants even care for the aphids' eggs. The ants collect and carry the eggs to their own nests, where the eggs are carefully guarded.

Aphids are the main source of food for these ants. Whenever an ant is hungry, it strokes an aphid with an antenna. The aphid responds by excreting a sweet substance called honeydew, which the ant eats. The relationship reminds one of a farmer who keeps milk-giving cows. The ants care for and protect their aphid "cows." And the aphids provide the ants with food.

There are other examples of symbiosis in the ant world. One group of ants lives in partnership with the bull-horn acacia tree. The ants protect the tree from insect enemies, and the tree provides the ants with food and shelter. (See December 23 Science World, page 12.)

It is not difficult to find many more examples of symbiosis in the animal and plant worlds. Tick birds, for instance, feed on ticks that burrow into the skins of ante-

lopes and other animals. So, while the birds are assured of a constant food supply, the antelopes are relieved of the bothersome ticks. A bird known as the Nile plover lives symbiotically with the crocodile. Possibly you have seen nature films showing these small birds perching inside the open mouth of a crocodile and pecking at the animal's teeth. Actually, the bird picks off leeches that draw blood from the crocodile's gums.

Nearly every beginning student of biology is introduced to "nitrogen-fixing bacteria." These are important to legumes such as clover, peas, and alfalfa. If you uproot any of these plants and wash the soil away from the roots, you will find tiny nodules attached to them. The nodules contain a certain kind of bacteria that live symbiotically with the legumes. They do for the plant what the plant cannot do for itself — namely, make use of the nitrogen gas in the atmosphere. The bacteria change the nitrogen into compounds called nitrates. Because nitrates are soluble in water, they can enter the plant by diffusion. The plant, in turn, gives the bacteria shelter and protection.

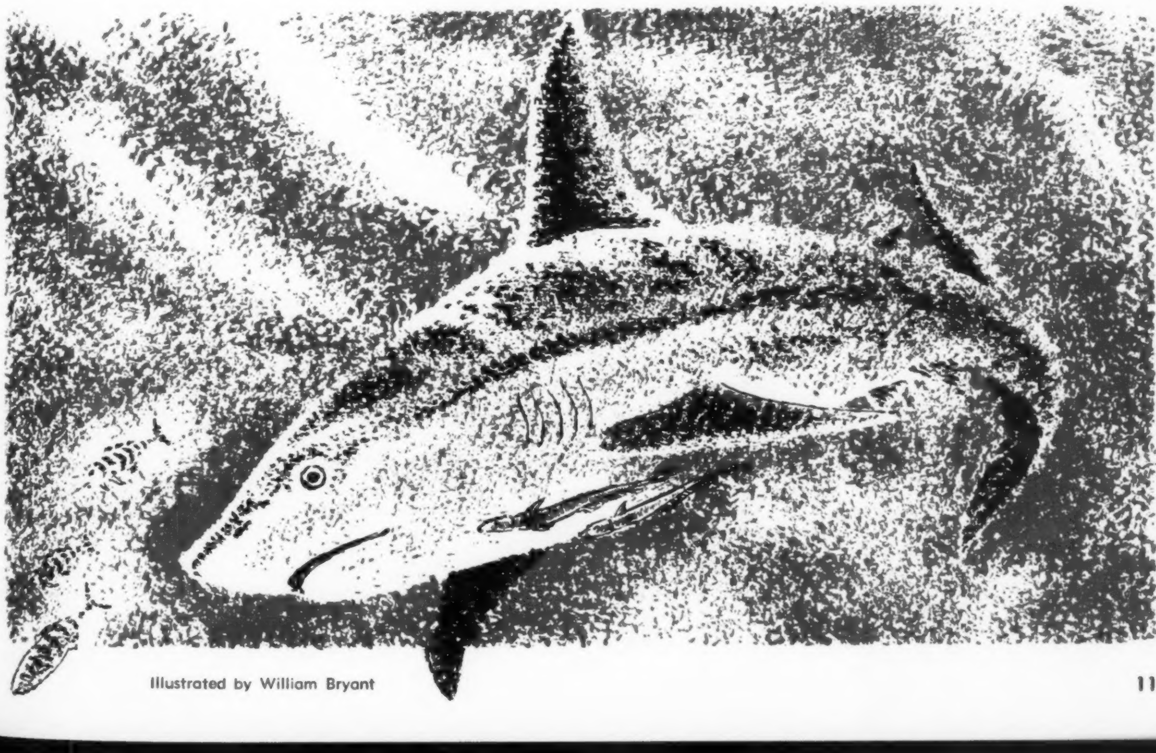
There's only a fine line between symbiosis and another kind of biological "togetherness" — parasitism. When two organisms live together but one is harmful to the other, that is parasitism. Mistletoe is a plant parasite. It cannot produce its own food, but grows on a tree — usually an apple, poplar, or maple — from which it draws its nourishment. The mistletoe contributes nothing to the tree's well-being.

Man is often a host to plant and animal parasites. Among the fungus plants that attack man are those that cause ringworm and athlete's foot. Disease-causing parasites in the plant family include the bacteria that cause diphtheria, typhoid fever, cholera, bubonic plague, and other human diseases. Malaria and sleeping sickness, on the other hand, are caused by parasites in the animal family. But there is, you might say, a kind of justice at work. Even parasites are, in their turn, plagued by other parasites, as described in these amusing lines:

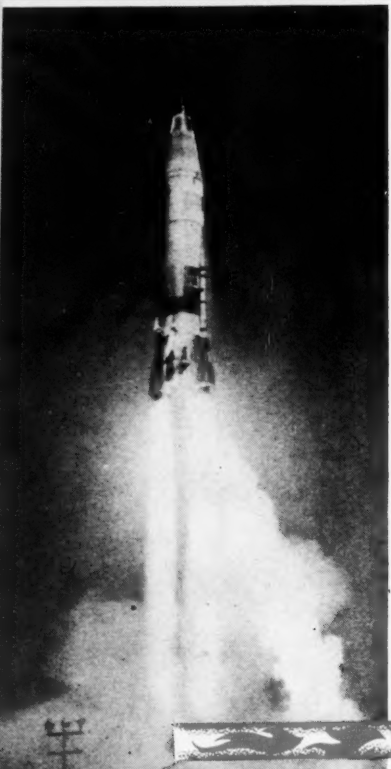
Big fleas have little fleas
  Upon their backs to bite 'em
And little fleas have lesser fleas
  And so — ad infinitum.

PORTABLE 'HOME' formed by marine animal called a sponge surrounds and protects hermit crab. Sponge benefits by crab's movements, which probably enable it to get more food.

SHARK RECEIVES no benefits from its companions — remoras, which attach selves to shark's belly, and striped pilot fish. But they eat leavings of shark, are protected by its presence.



Illustrated by William Bryant



— Atlas ICBM photos from Convair, Division of General Dynamics Corp.

Rocket and missile quiz

Do you know . . .

the difference between a jet, a rocket, and a missile?

how an ion rocket will operate?

what types of rockets will be used in flights to planets?

Test your knowledge by answering the questions below

What is the law of physics that explains the operation of jets and rockets? Who first stated this law?

To every action, there is an equal, opposite reaction. Isaac Newton.

How do rocket-propelled and jet-propelled vehicles get their push?

Fuel burns, forming hot gases. The gases expand violently and escape from the rocket, at great speed, through an exhaust. The action that forces the gases backward is balanced by a reaction that pushes the rocket forward.

What's the chief difference between jets and rockets? How does this affect their use?

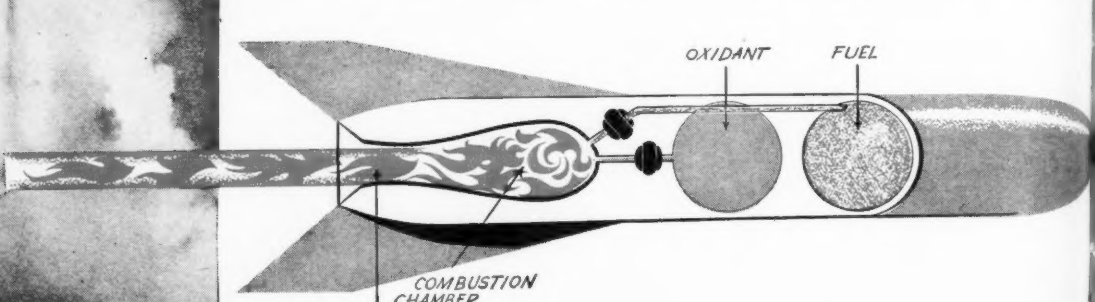
Jet vehicles are air breathers — that is, they use the oxygen in the air to burn their fuel. This limits them to altitudes where oxygen is available. But rockets carry their own oxygen or other oxidizer. So they can operate in outer space, where there is little or no air.

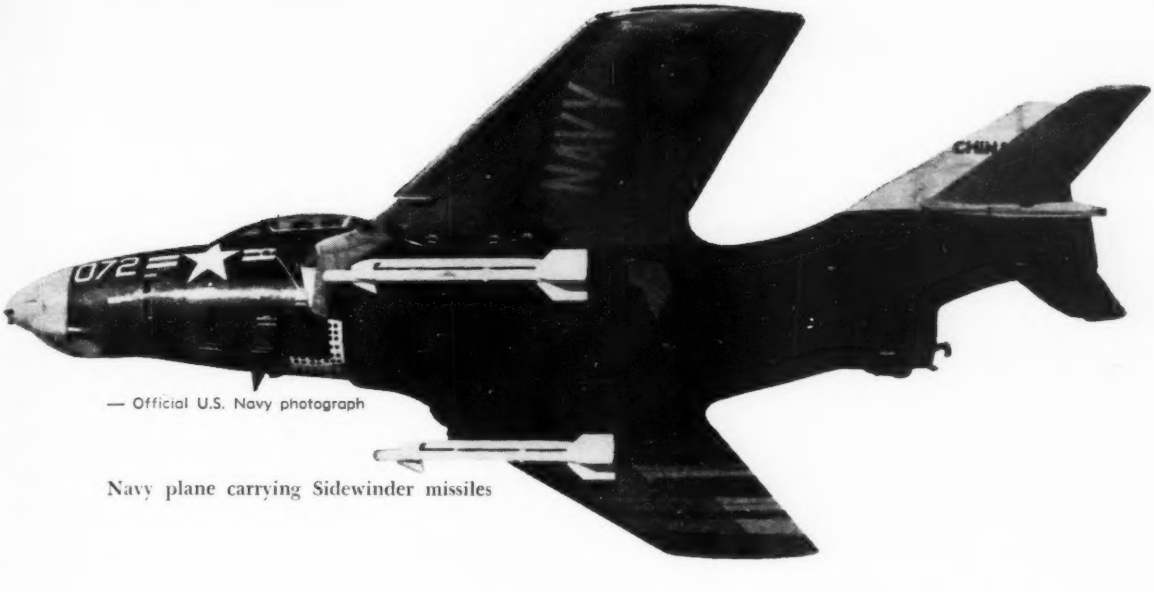
If a rocket is propelled by hot gases pushing against the air, how can a rocket be propelled in airless space?

A rocket is *not* propelled by gases pushing against the air. It's propelled by the force of gases pushing against the rocket itself. In fact, the less air there is, the better the rocket works. For air offers resistance to the gases being forced out of the rocket, reducing their speed. And as their velocity decreases, so does the velocity of the rocket.

Is the rocket below liquid-propelled or solid-propelled? How do you know?

It's a liquid-propelled rocket, since fuel and oxidizer are stored in separate tanks and mixed and burned in the combustion chamber. In a solid-propelled rocket, oxidizer and fuel are combined in a solid charge that is burned.





— Official U.S. Navy photograph

Navy plane carrying Sidewinder missiles

Some air-to-air missiles, such as the Navy's Sidewinder, will fly right up the tailpipe of an enemy jet. What is it that these missiles home on?

Infra-red radiation given off by the jet's hot engine.

Are all rockets missiles? Why or why not?

That depends on what you mean by the word missile. The broad meaning of the word is: any object thrown or otherwise projected. In that sense, all rockets are missiles. But a missile, in the modern military meaning, is a self-propelled, unmanned weapon. Using this meaning, all rockets are not missiles. For many rockets are not used as weapons, and some may soon be manned.

Are all missiles rockets? Why or why not?

No. Under the broad definition of the word missile (see preceding answer), even a stone could be a missile. As for modern military missiles, some are rocket-powered and can therefore be called rockets, but others are jet-powered.

What's the difference between a guided missile and a ballistic missile? How does this affect their use?

A guided missile is guided throughout most or all of its flight to a target. Since it can change direction in mid-flight, it can be used against moving targets. A ballistic missile receives guidance for only a brief period, during its early powered flight. After its engine burns out, it coasts the rest of the way to the target without guidance in a trajectory similar to that of an artillery shell. For this reason, ballistic missiles are used against fixed targets.

What is a three-stage rocket? How does it work?

A three-stage rocket consists of three rockets "hitched" together, one on top of the other. The first stage (or bottom) is ignited on the ground and carries the whole vehicle upward. After the first stage burns out, the second stage fires. The first stage then falls away — as does the second stage in its turn, when the third-stage rocket takes over.

Instead of putting rocket stages one on top of the other and firing them in succession, why not fasten them side by side and fire them all together?

By firing the stages one after the other, weight can be discarded when it is no longer needed. Thus the same amount of propulsion carries the vehicle faster and farther.

Does a rocket commonly travel at a faster or a slower speed than the velocity of its exhaust gases? Why? Under what conditions might it travel at about the same speed?

According to Newton's law of action and reaction, a rocket might be expected to travel at the same speed as that of its exhaust gases. But air resistance slows the speed of the rocket to less than the exhaust velocity. In outer space, however, there would be practically no air resistance. So a rocket could travel at about the speed of its exhaust gases.

In what two ways can the speed, and thus the range, of today's chemical rockets be increased?

(1) By using a fuel-oxidizer combination that raises the speed of the exhaust gases; (2) by increasing the amount of fuel carried so that it can burn for a longer time (as long as the fuel keeps burning, the rocket will go faster and faster).

What is a rocket's specific impulse?

The amount of thrust obtained when a pound of propellant is burned in one second.

What is meant by a rocket's thrust-weight ratio?

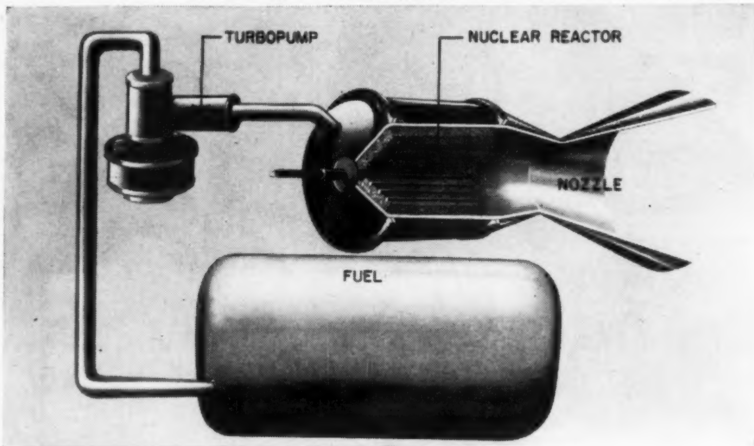
The ratio of a rocket engine's weight to the amount of power it produces.

What energy changes take place in the operation of a chemical rocket?

Chemical energy stored in the fuel is converted into heat energy. Heat energy is changed into mechanical energy.

How will a nuclear rocket differ from a chemical rocket in energy changes and in basic operation?

— Drawing from Rocketdyne, Division of North American Aviation, Inc.



SCHEMATIC DRAWING of a possible nuclear rocket engine.

Nuclear energy will replace chemical energy. An atomic reactor will heat the gases to be expelled. Since fuel will not be burned, no oxidizer will be needed.

How will an ion rocket differ?

In an ion rocket, nuclear energy from an atomic reactor will be converted into heat energy, which will be changed into electrical energy. A gas will be ionized by the electricity, and the ions will be expelled from the rocket. More specifically, vaporized propellant will be fed into an electrically charged chamber. There, an electric arc or metallic plate, generating 100 times as much heat as a large electric stove, will knock loose an electron from each molecule of the propellant. Since an electron is a negatively charged particle, each molecule will then have a positive charge. In other words, it will be an ion. The ions will be pulled out of the chamber by the attraction of an electromagnetic field. They will be jolted by 12,000 volts to high velocities. The speeding ions will then shoot out of the rocket's exhaust nozzle.

How will chemical, nuclear, and ion rockets compare in specific impulse and in thrust-weight ratios? Why?

A chemical rocket's fuel is burned up fast, and the resulting gases rush out of the rocket at a high velocity. For this reason, chemical rockets have a relatively low specific impulse — they get, so to speak, few miles to the gallon. They do, however, have a high thrust-to-weight ratio. For their weight, they pack a lot of power.

The source of power in nuclear and ion rockets — say, uranium — has a great amount of energy locked up in it. A little uranium will last a long time, as witness the long cruising distances of atomic submarines. So nuclear and ion rockets will have a high specific impulse. But they'll have a low thrust-weight ratio, since the reactor and its shielding (needed to seal off deadly radiation) will be heavy. Further weight will be added to the ion rocket in the form of equipment needed to convert heat energy into electrical energy.

What type or types of rocket — chemical, nuclear, or ion — will be best suited for a flight (1) from the earth to a satellite station orbiting the earth; (2) from a satellite station to a distant planet? Why?

(1) A chemical rocket will be best, since it has a high thrust in relation to its weight. This high thrust is necessary to overcome the strong pull of the earth's gravity. (2) For satellite-planet trips, nuclear and ion rockets will be more suitable. A vehicle operating from a satellite will be weightless, so its thrust can be small. But it must have a long-lasting energy source to cover the tremendous distances to the planets.

Suppose you were designing a rocket to be fired from a balloon at a high altitude. Would you make the rocket's control fins larger or smaller than the fins of a similar rocket to be launched from the ground? Why?

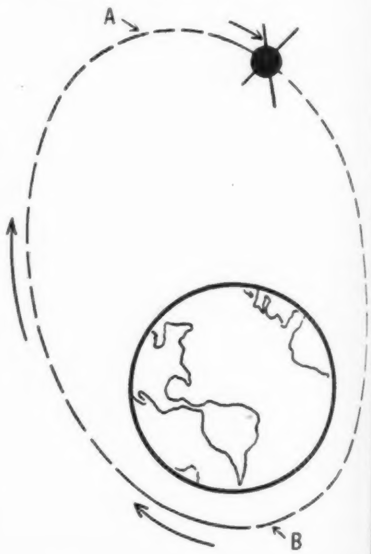
The rocket fired from a balloon should have larger fins. At a high altitude, the air is thinner than it is at ground level. This means there would be less air pressure against the fins' surfaces. Therefore, fins with large surface areas would be required for effective control of the rocket.

What sort of control fins would you put on a rocket to be launched from a space station several hundred miles above the earth? Why?

Since there would be practically no air at this altitude, ordinary control fins would be useless. You might, however, put the fins in the blast of the rocket's exhaust. By moving the fins, the direction of the exhaust could be controlled and the rocket thus steered. Another possibility: forget the fins, but provide a means of swiveling the motor to change the direction of the exhaust.

What do we mean when we say air becomes thinner?

The molecules of air aren't packed so tightly together.



What geometric curve is traced by the path of a satellite orbiting the earth? What are points *A* and *B* in the satellite's orbit called?

An ellipse. Point *A* is the satellite's apogee — its greatest distance from the earth. Point *B* is the peri-

gee — its smallest distance.

What two conditions would have to be met exactly if a satellite were to be put into a circular orbit around the earth?

The satellite would have to be exactly parallel to the earth's surface when ejected into orbit, and its speed would have to be precisely equal to that required to balance the pull of gravity.

What holds a satellite in its orbit?

Its speed gives it enough centrifugal force to balance the pull of the earth's gravity.

How can observations of a satellite's orbit help us determine the shape of the earth?

Irregularities in the shape of the earth produce slight changes in the pull of gravity. These changes are reflected in the satellite's orbit.

Why do present satellites eventually fall from their orbits?

When a satellite passes through the perigee of its orbit, it encounters a small amount of air resistance and loses a little of its momentum. As a result, it will not go quite so far out when moving toward its apogee. Gradually, the satellite approaches the earth. More of its orbit lies inside the thicker atmosphere. As the orbit becomes a tighter and tighter spiral, the satellite encounters denser and denser air. It finally runs into so much aerodynamic heating that it burns up.

Why is a satellite ideal for measuring radiation from the sun?

Much of the sun's radiation is absorbed by the earth's atmosphere. The satellite is, practically speaking, above the atmosphere. So it can measure the full force of the sun's radiation.

What are the three main layers of our atmosphere? At about what altitude do they begin and end?

The troposphere begins at the surface of the earth and ends at an altitude of from five to ten miles (its thickness varies with location). The stratosphere begins about where the troposphere leaves off and reaches up to about 50 miles. On top of the stratosphere is the ionosphere. No one knows exactly how far it extends.

— Official U.S. Navy photograph

HITCHHIKING ROCKET is lifted by balloon to be fired from a high altitude.

How the brain enables man to use speech effectively . . .

what happens when a person speaks . . . how language influences culture . . .

these are some of the topics explored by

The science of language

By Edmund H. Harvey Jr.

A preview of the Bell System Science Series program, "The Alphabet Conspiracy"

■ You probably said a great deal more before you were six years old than you have said ever since. Phonetically speaking, that is.

Here's why. In their babblings, infants and young children all over the world make many different and distinct speech sounds. These sounds — called "phonemes" — are the basis of all languages. But each language uses only so many phonemes. To speak English, for example, forty-five phonemes are required. As children grow older, they discover more or less unconsciously, through listening and imitating, just which phonemes they must use to be understood. By the age of six, a child has usually picked out the sounds of his native language.

Linguistic science

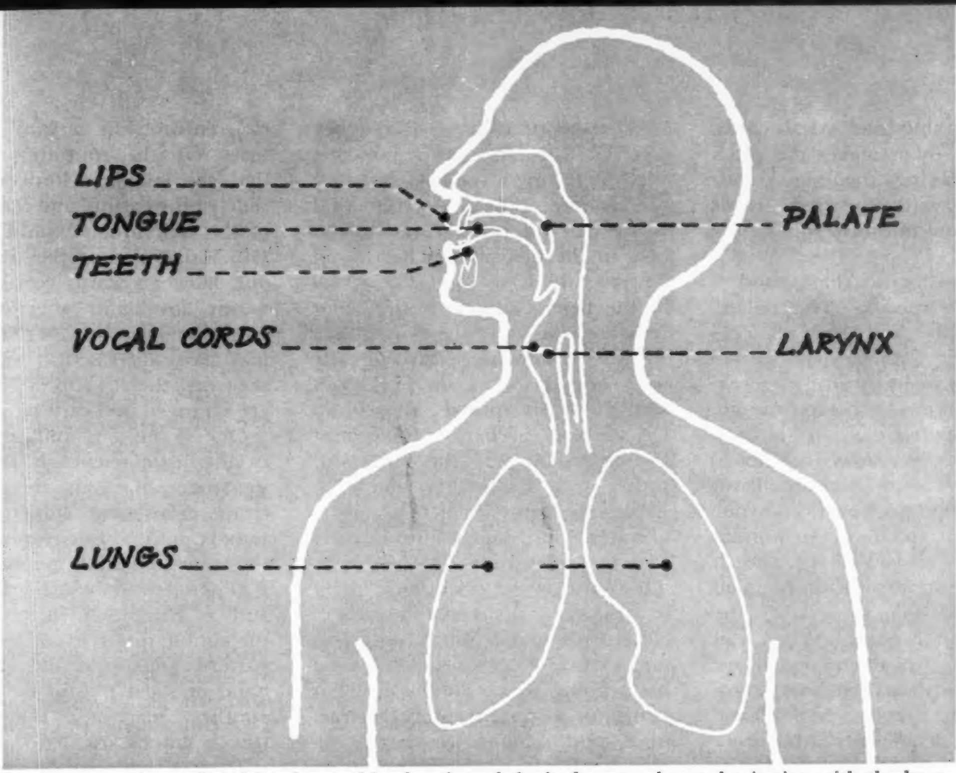
An explanation of the importance of baby talk is one of the surprises of a forthcoming film, "The Alphabet Conspiracy," in the Bell System Science Series. Perhaps the biggest surprise to some will be the science film's subject: language. But it shouldn't be. Using highly complex machines and methods, many scientists are now studying language. The more man learns about language, the more he finds out about himself and his world. And that is — and always has been — the basic goal of science.

The study of how men communicate with each other is essentially the province of the linguistic scientist. Just as the chemist begins with elements, the linguistic scientist is interested in phonemes. Having identified these basic speech sounds, the linguistic scientist can analyze more complex sounds — words and phrases and sentences. Similarly, the chemist applies his knowledge of the elements to the study of compounds.

One of the points stressed throughout "The Alphabet Conspiracy" is this: sound, rather than an alphabet, is the true basis of language. Man has been speaking for roughly seventy times as long as he has been writing. Even today, millions of people have no written language, and many of the world's five thousand languages have no alphabet. Moreover, the absence of a written form doesn't mean that a language is crude or primitive. The spoken language of so-called primitive peoples can be highly developed and intricate.

Though the linguistic scientist doesn't know exactly how or where human beings began to speak, he has a very good idea of *what happens* when a person speaks. The process begins in the lungs, as air is pushed up through the larynx toward the mouth. When a person is speaking, the air is forced through the vocal "cords," which are not really cords at all. They are tough membranes attached to the sides of the larynx. The air from the lungs starts the membranes flapping and slapping, much like deflated balloons in front of a powerful fan. The vibrations of the membranes produce sound waves. We control the *pitch* of this sound by tighten-

FIRST TALKING MACHINE, invented about 1780, produced sounds of human speech. Bellows (*X*) was pumped to force air into box (*A*), where air vibrated reed, producing sound. Vowel and some consonant sounds were made by manipulating hand at mouth of horn (*C*), others by pressing keys.



HUMAN SPEECH is produced by the combined action of the body parts shown, beginning with the lung

— Courtesy Bell Telephone Laboratories, Inc.

HOW SOUNDS APPEAR when they are transformed into visual patterns by a sound spectrograph. From top to bottom: siren's wail, human whistling, oboe solo, ocarina solo, and ship's bell (time here: five bells).

ing or relaxing our vocal cords. Tightening them makes the pitch higher; relaxing them makes it lower. But with the vocal cords alone, we couldn't form intelligible words.

It's in the mouth that sound is shaped into speech. The palate, tongue, teeth, and lips all contribute. They can be made to act individually or in various combinations to produce the recognizable sounds of speech.

By talking very slowly and exaggerating each sound, you can get an idea of all that goes on inside your mouth when you talk. In normal talk, however, you shape speech sounds almost unconsciously. You may also be able to identify the phonemes in a word. When you say "either" (pronouncing it eether), you use five phonemes, something like this: "i-ee-th-uh-rr." When you say "either" the other accepted way (eye-ther), you also use five phonemes: "ah-ee-th-uh-rr."

In arriving at an understanding of speech mechanics, linguistic scientists have had the valuable help of both physiologists and physicists. Physicists can help explain how speech is produced and emitted by the human speech mechanism. And physiologists can explain the functions of each of the organs involved.

Speech, of course, is only one of many mediums of communication, though it's the most important. Besides writing, there are other more exotic mediums. For instance, on the rugged island of La Gomera in the Canary Islands off the west coast of North Africa, the natives use a "whistle language" to communicate with each other across the island's deep gorges. Consonants and vowels in the Gomeros' language are designated entirely by the pitch of the whistle. The natives, can understand each other over a distance of three miles. Another exotic medium of language is found in the jungles of Africa: drum language, or the so-called bush telegraph. The natives beat out syllables of words by continually varying the rhythm of drumbeats. Still another medium is the sign language developed by the North American Indians, in which all the gestures stand for whole concepts.

What about animals? Don't they communicate, too? Yes, in some very interesting ways. A worker bee, for example, does a ceremonial dance that informs the rest of the bees in the hive that it has found flowers full of nectar. The speed of the bee's dance tells the other bees how far away the flowers are. And a chimpanzee has actually been taught to say seven English words. Of all animals, the chimp has a vocal mechanism that most resembles man's. But it's still pretty crude by comparison.

It's not man's vocal mechanism, however, that enables him to use speech so effectively. It's his brain. The brain is the essential element in language, as it is in almost every activity of man. With his brain, man can think in words, plan what he is going to say and how he is going to say it, express abstract ideas and scientific concepts, express emotions, and give names to things.

Science of semantics

Psychologists, needless to say, are tremendously interested in the way the brain uses, and responds to, language. They want to know what words *mean* to the brain. Finding the exact meaning of words is the task of scientists working with semantics. Semanticists try to determine exactly what the words of a specific language mean to the people that speak that language. Obviously, this knowledge is also important in making accurate, meaningful translations of one language into another.

Anthropologists are particularly interested in language as it relates to different cultures. Each culture, they have found, creates a language that will best express its particular way of life. Arabic, for example, has some six thousand words referring to camels and camel equipment. Reason: the camel is one of the most important aspects of the nomadic desert life led by many Arabic-speaking peoples. For much the same reason, the Eskimos have a dozen special words used to tell about snow.

One very provocative theory has grown out of studying the relation of language to culture. Some anthropologists feel that language isn't entirely the servant of a culture. On the contrary, they feel that the language limits the concepts of the culture and the thought of the individuals within it. Certain Melanesian peoples, they point out, have no words corresponding to our "love" and "affection." The anthropologists suggest that this may have a great deal to do with the way these peoples' marriages are arranged and carried out.

One of the most important tools in linguistic science is the sound spectrograph. This intricate machine transforms human speech sounds into visible forms. Scientists can then study phonemes and the patterns they make in detail and at length. A further feat of the sound spectrograph: when the patterns are copied and painted by hand on clear plastic and fed into another machine, the original speech sounds are heard again.

Devices that reproduce sound by converting it to electrical impulses and then back again are all around us — the phonograph, the telephone, the movie sound track. One of the earliest such machines was invented by a German, Wolfgang Von Kempelen, about 1780. Von Kempelen's talking machine was laboriously modeled after the human speech mechanism. It had bellows, reeds, and valves as substitutes for human organs. And it really did "talk," creating speech out of thin air.

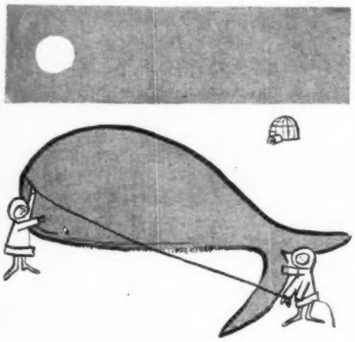
One present-day machine understands spoken numbers and can deal with them. Developed by Bell Laboratories, this machine is called "Audrey" (short for Automatic Digit Recognizer). Another machine — still in the very early stages of development — is the "Voice Typewriter." It takes dictation and types some words as they are spoken. However, to date the machine is limited to a few words carefully spoken by a suitable voice.

The new Bell System Science Series program, "The Alphabet Conspiracy," will be telecast over the NBC network Monday evening, January 26. Check your local TV listings for the time this program will be seen in your section of the country.

Judy Hunt of Webb City, Missouri, writes:

How does radar work?

When a beam of radio waves is transmitted from a radar set, it travels away from the set at the speed of light. If the beam hits a solid object in its path — such as an automobile, airplane, or ship — it is reflected back (also at the speed of light) to its source. One beam after another hits various parts of the object and bounces back. The beams are converted into a rough image of the object, which appears on a screen. The object's direction from the radar set is revealed by the direction from which the radar echoes come. The object's distance is determined by electronic circuits that measure the time it takes the echo to return to the set.



Robert E. Dean of Glendora, California, writes:

How are whales measured for weighing?

The weight of a whale is determined by a rule-of-thumb: one foot in length is about equal to one ton. So a whale 100 feet long would tip the scales, give or take a little, at 100 tons.

Janet Wattley of Ringwood, New Jersey, writes:

What determines eye color?

Characteristics such as eye color are carried by genes, the tiny particles that determine what we inherit from our parents. Genes are strung together like beads along the chromosomes. In each body cell, man has 24 pairs of chromosomes. Each pair consists of duplicate chromosomes carrying duplicate genes. An infant receives one chromosome of each pair from each parent. Often, a single pair of genes controls a particular trait. But in eye color, numerous genes seem to be at work. At birth, an infant's eyes are blue, but the color may change later. There seems to be one basic pair of genes that determines the difference between blue and brown eyes, several gene pairs with relatively minor effects. These secondary genes modify the blue or brown colors by making them darker or lighter or by restricting their colors to different parts of the iris of the eye.

Thomas Cantin of Ontario, New York, writes:

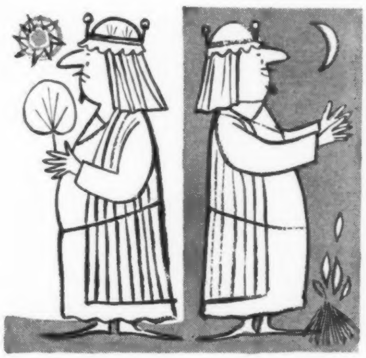
Why does a fluorescent bulb give off a glow in darkness when it is rubbed or touched by the hand?

Before touching the bulb, the person probably walked across a wool rug (or came in contact with some other appropriate material). In so doing, he set up a charge of static electricity in his body. The body can be a conductor of electricity. So when he touched the bulb, the static electricity in his body flowed through the lamp, producing the glow. Phenomena of this sort are common when the air is dry. (For a stunt involving static electricity, see "Unpepper the Salt," page 26.)

Marion Madsen of Ayer, Massachusetts, writes:

Why are deserts hot in the daytime and cold at night?

Because desert areas have relatively few clouds. Dry, arid desert land lacks bodies of water, forests, and fields that give off water vapor. In areas where these exist, water vapor rises into the air and forms clouds, or visible moisture. The clouds act as a parasol by day and a blanket by night. During the day they absorb and/or reflect the sun's heat. At night they tend to keep the earth from losing the heat accumulated during the day. Without clouds, there is nothing to modify extremes in desert temperature.



Stan Glantz of Toledo, Ohio, writes:

What is the highest altitude man has reached? Who reached it and when?

The highest altitude reached by a human being is 126,200 feet. The record was set by the late Captain Iven C. Kincheloe in a Bell X-2 rocket research ship on September 7, 1956.

Questions from readers will be answered here, as space permits. Send to: Question Box, Science World, 575 Madison Avenue, New York 22, N.Y.

Science in the news

Giant satellite brings space goals closer

". . . my voice is coming to you from a satellite traveling in outer space." These words, spoken by President Eisenhower, were among the first heard from the Air Force's Atlas ICBM as it orbited the earth. The huge missile weighed nearly 4½ tons.

The first "talking" satellite has helped pave the way for human space flight and for space-age communications. Atlas missiles are sufficiently big, powerful, and accurate to serve as manned satellites in space. An Atlas could also become a giant communications center in space, instantly relaying cables, "mail," and even television programs to any point on earth. (See satellite-post office story on next page.)

The orbiting Atlas sent its tidings to the world by recording messages received from four U.S. stations and then playing them back. Radio signals from the stations triggered the Atlas' tape recorder into action.

The short-lived satellite swung around the earth every 101 minutes at altitudes ranging from 118 to 625 miles. The Atlas' 360,000-pound thrust had sent it into orbit 4½ minutes after it had left the launching pad at Cape Canaveral. A built-in, high-accuracy guidance system had steered the vehicle into orbit. Previous satellite firings had provided guidance only until the last and most difficult stage – that of nudging the satellite into orbit.

The Atlas consisted of five rockets: a big sustainer rocket, two boosters, and two small guidance rockets. Only the two booster rockets dropped off – the rest went into orbit. Except for the big rocket engine, the entire protective skin of the 85-foot-long missile was made of stainless steel. Future Atlas satellites could serve as:

- Giant eyes that would observe the world's weather in the making, track hurricanes, vastly improve weather forecasting.
- High-flying observatories from which telescopes would view the universe without interference from the murky atmosphere surrounding earth.
- Space stations from which small rockets could be launched to investigate Mars or Venus.

Cold antarctic winds trigger warmer weather

The antarctic has its own "defrosting" mechanism. Meteorological studies made on a trip across the polar ice led IGY scientists to this discovery. Here's how the mechanism works:

In the winter months, frigid air pours down from the polar plateau. These sub-zero air currents create violent cyclones over surrounding oceans. The cyclones push warmer sea air over the continent. If it weren't for this system, said one IGY scientist, temperatures would be far colder than the low-temperature record of about 125 degrees below zero recently reported at a Soviet antarctic station.

Monkey in nose cone lost in Atlantic

The first monkey to travel in space was lost at sea after furnishing valuable data on man's chances for surviving space flight. Sent up in the nose cone of an Army Jupiter IRBM, the Latin-American squirrel monkey soared hundreds of miles into space. Purpose of the test was to find out how a human might react under similar conditions. The male squirrel monkey was picked for two reasons: its small size (it weighed less than a pound) and its anatomical similarity to man.

After a perfect take-off, electronic instruments in the Jupiter reported that the monkey suffered no harmful effects during the first few minutes of flight. Despite some irregularity at first, the monkey's heartbeat returned to normal during an eight-minute period of weightlessness. After 1,500 miles and 15 minutes, the nose cone (now separated from the rest of the missile) plunged into the Atlantic off the island of Martinique in the West Indies. Army-Navy task forces, which had recovered three Jupiter nose cones in the past, failed to find it. Protests against the experiment were registered by animal lovers and animal-protective groups. However, Army officials said such tests were needed before men could venture into space.

Small but speedy describes Rotorcycle, one-man helicopter built by Hiller Aircraft Corporation. Weighing only 300 pounds, it can travel up to 70 miles per hour. Rotorcycle is the only completely foldable aircraft with full helicopter capabilities. One man can assemble the small craft for flying in less than five minutes.

Man-made noise tests space-flight equipment

Noise intense enough to shatter the human eardrum is being used to test missile and rocket equipment. It can "outshout" 450 ordinary loud-speakers and is more than 20,000 times as loud as a television set turned to maximum volume.

Research engineers know rockets and missiles encounter intense noise in space flight. As ICBM nose cones re-enter the thicker part of the earth's atmosphere, for example, they meet intense sound vibrations. These can cause sensitive electronic gear to go haywire. Even the noise of the vehicle's own engine can shatter delicate parts.

To study such problems, engineers have developed their own super-noise in the laboratory, using powerful loud-speakers. This noise is too intense to be heard by the human ear. (And it would set up unbearably painful vibrations in the body and would burst a man's ear-drums.) Man-made laboratory noises of more than 160 decibels have been produced by research engineers of Avco Manufacturing Corporation and of Radio Corporation of America. When noise reaches 120 decibels, it becomes deafening to the human ear. When it reaches 130 to 140 decibels, it becomes painful.

More than 300 viruses now known to exist

Eighty viruses that attack human beings have been discovered by scientists in the last ten years. This brings to some 300 the total of viruses known to attack plants and animals.

Since their discovery forty years ago, viruses have been a source of mystery. Most of them are too small to be seen through an ordinary microscope. Not until the invention of the electron microscope in 1932 were scientists able to observe virus structures. Now scientists have determined that most of the viruses attacking man seem to be spherical in shape, while those in animals are elongated.

Scientists call viruses "semi-organisms." Reason: viruses have many characteristics of life, but can't be described as living things. They reproduce, vary in kind, and can adapt themselves to their environment. But they cannot survive and multiply when they are apart from other living matter. Parasites, they take from the cells they invade the chemicals needed for reproduction. This action may kill the cell.

One of the newly discovered viruses is a salivary gland virus. It is found in at least 10 per cent of healthy nursery-age children in cities. It is usually dormant, but can cause diseases that destroy various organs in the body. If the infection becomes widespread, it usually causes death. Another recent discovery is a group of viruses that cause various types of colds. These, too, are especially active in children.

Mail via satellite forecast for future

An earth-satellite postal system has been outlined by engineers at the Radio Corporation of America. They say the system could deliver mail faster and cheaper between the United States and Europe. Mail would be handled as follows:

Letters on standard forms would be electronically converted into microwave radio signals at major post office centers. The signals would be transmitted to a special ground station, which would relay them to the satellite high above the ocean. The satellite, in turn, would transmit the signals to the appropriate post office on the other side of the ocean. There, they would be electronically converted back into letter form for delivery.

The very high-frequency radio waves used for such communications travel in straight lines. To transmit them over long distances, relay stations are now used. These stations must be close enough so that signals can go in a straight line from one to another without being blocked by the curvature of the earth. This system works fine on land. But extending such stations across the ocean isn't feasible. A satellite high above the ocean, however, could send or receive radio waves in a straight line to or from either shore.

The satellite would move in an orbit parallel to the equator at an altitude of about 22,000 miles. It would travel at the same speed as the earth's rotation. So it would remain in a fixed position over the ocean.

The satellite would contain light-weight receiving, amplifying, and transmitting equipment. Power to run the equipment would be supplied by solar cells or by storage batteries.

Another possibility would be the use of satellites that are simple metallic spheres. They would simply reflect the signals from shore to shore. This system would require very powerful transmitters.

Engineers estimate that letters sent by satellite would cost roughly from 12 to 15 cents each. They would be delivered two to two and a half days after mailing.

News in brief

- A cat runs in terror from a mouse after being given a whiff of a new nerve gas. Army researchers developed the gas for use in combat. If enemy troops were sprayed with the gas, they would temporarily lose their will to fight, says an Army spokesman. The gas does no permanent harm.

- An electronic "brain" at the National Biscuit Company can help bake in a single month enough cookies to stretch twice around the globe. Called a master control console, it directs a series of operations, each in perfect time and sequence. Before each day's operations, the console is pre-set to deliver to a particular mixer the right amount of ingredients for each product to be baked. When a "start" button is pressed, the console withdraws the ingredients from a storage pantry, weighs each one, sifts the dry materials, and takes them by automatic conveyor to a mixing machine.

- Pioneer IV, the Army's next moon shot, is scheduled for sometime around February 1. Defense officials say the probe may be this country's last lunar shot until the middle of 1959. Pioneer III, launched December 6, fell to a flaming death over French Equatorial Africa thirty-eight hours and six minutes after it was fired.

- A new experimental technique uses "silent sound" to weld together two overlapping pieces of metal. The metals pass between two metal wheels. High-frequency sound waves are used to vibrate the wheels rapidly back and forth. The rims of the wheels press the two overlapping pieces of metal tightly together and "knead" them. This action brings the surface crystals of the metals into moving contact. The lattices (or framework) of the crystals intertwine, binding the metals firmly together. In this way, the vibrating wheels "sew" a continuous welded seam. The seam looks like a typical electric weld, but needs no electric current or outside heat. And the metals aren't deformed as they usually are in cold-welding processes.

- Hydrazine, a liquid rocket fuel, is also being used to treat mental and physical ailments. But where rocket engineers deal with it in terms of tons, medical men weigh it out in milligrams. Hydrazine is a compound composed of two atoms of nitrogen and four atoms of hydrogen. Derivatives of hydrazine have been used to treat human diseases ranging from mental disorders to TB.

Sea life but no sea

Careers

James Atz gives clam snack to Olaf the walrus at New York Aquarium pool

— Photo from New York Zoological Society

■ "Nice set of tusks on him, don't you think?" James Atz, Associate Curator of the New York Aquarium, pointed proudly to Olaf, a 1,200-pound walrus cavorting in a giant tank. "Olaf is the only walrus in captivity in the Western Hemisphere, and he's become quite a celebrity. But he's only one of hundreds of marine animals living here at the Aquarium." The Curator continued to stroll along the Aquarium hall past the glass tanks, commenting on the unusual coloring of one species, the rarity of another.

Mr. Atz is an ichthyologist — a natural scientist whose specialty is fishes. And he knows the workings of the Aquarium from top to bottom, for he started at the bottom. After he was graduated from Cornell University with an A.B. degree and a major in biology, he worked at the Aquarium as a volunteer. Several months later, he joined the staff as a laborer, serving, for example, as a "tank man" (who sees to it that the aquatic homes of the animals are as healthful as possible). Next, Mr. Atz worked as a lab technician. A few years later he became Assistant Curator, and last year he became Associate Curator. While he was working his way up, he earned a master's degree at New York University. Now he's completing his doctoral thesis for a Ph.D. at NYU.

"The public only sees our animals on display, but we do much more than collect animals for exhibition," Mr. Atz said, leading the way into his office. "To the limit of our resources, we try to re-create within these walls the natural habitat of each aquatic animal. Multiply this one animal by several hundred, and you have a giant and complicated task."

To tackle this task, the scientific staff of an aquarium must have a vast store of knowledge about its animals. They must know where and how they live, what they eat, their physical characteristics, their peculiarities.

The animals must be content — and so must the public. For example, instinct may prompt a certain species of fish to spend its time hiding behind rocks or coral. But at the same time, the public is entitled to see the fish. The scientists' job is to work out a compromise acceptable to both sides.

A constant vigil must be kept on the animals. For no apparent reason, one may start to bully another. The offending animal must be moved immediately to an environment where it can get along with its neighbors.

From time to time, animals get sick. Their ailments must be diagnosed and treated.

"A scientist's training should prepare him to meet all these problems," James Atz says. "But not all the answers are found in textbooks. Practical

experience is a valuable teacher in aquarium work."

An aquarium scientist does some problem-solving for the public, too. Mr. Atz regularly deals with a steady stream of letters and telephone calls requesting help or advice. A housewife may call for help in treating an ailing goldfish. A small boy may write for advice on caring for his pet turtle. The Curator also works closely with scientific institutions from all over the world, exchanging know-how and research data. Typical is a recent letter from a city in a foreign country asking for help in setting up a new aquarium.

Research is a large part of James Atz' work. His special interest is the genetics of fishes. And his doctoral thesis concerns the heredity and pigmentation of platyfishes and swordtails. Tropical fish fanciers are familiar with the common species of these two fishes, which are often seen in home aquariums. Mr. Atz has collected several species of platyfishes and swordtails on field trips in Mexico. He has brought back both live and preserved specimens for study at the Genetics Laboratory of the New York Zoological Society. (The Society is the parent organization of the Aquarium.)

James Atz has written several scientific papers as a result of his research. He has co-authored a standard reference work on the physiology of fishes, and he's also written some fifty popular books.

Mr. Atz interrupted his work to enter the Army Field Artillery during World War II. On his return to the Aquarium, he soon discovered that an attractive lab technician had joined the staff in his absence — and married her. Mrs. Atz, who holds a master's degree in biology, has several technical publications to her credit. When their three children are older, the Atzes plan to collaborate in scientific research.

In his position at the Aquarium, Mr. Atz often advises young people on careers in biological science. He has some very definite ideas on the subject. One sure-fire clue to a person's potential as a biologist, he says, can come at a very early age: a genuine curiosity about living things, manifested, perhaps, by an interest in bird-watching, collecting cocoons, or keeping pets. Indeed, an interest in living things is absolutely essential in all biological fields. So is the ability to concentrate on a problem and stick to it even when the going looks tough. If a student is truly interested in his high school biology courses — interested enough to read more widely in them outside of school hours — he's off to a fine start.

"When a young person enrolls in college, he should bear in mind that courses in mathematics, physics, chemistry, and foreign languages are at least as important as his biology classes. I can't stress enough the importance of being able to speak and write English well. If possible, a college student should take a course in public speaking. He'll find that being able to write and state ideas clearly is an invaluable talent in the biological sciences. And he shouldn't neglect the arts. After a student has completed his undergraduate work, he should try to take as many graduate courses as possible. With every passing year it becomes increasingly difficult to progress in biology without a Ph.D. That's why I'm getting mine now. I wish I had done it before." Often a student can arrange to take graduate courses while working in his field. Or he can ease the financial problem by teaching while studying for an advanced degree. If he shows promise, scholarships aren't difficult to come by.

"I tell young women who ask me about future careers in biology that the field is slightly more difficult for a woman to enter. A woman must work harder to prove herself than her male counterpart. Once she has done it, the field is unlimited. Many women go into laboratory technology. Often they are better suited than men to phases of lab work that call for precision and manual dexterity.

"I'm sorry to say that salaries for scientists in aquariums, zoos, and museums rank no higher than those of the teaching profession," says James Atz. "But efforts are being made to bring them up to university levels. Many scientists augment their incomes by teaching in universities. Research projects and field trips help to compensate for the lower salaries, too. They offer enriching and rewarding experiences to the serious biologist."

Yours for the asking

North American Aviation, Inc. reports that supplies of *Atoms That Help You* are exhausted and it cannot fill the requests received from *SW* readers.

Consolidated Edison has published an easy-to-read, illustrated booklet that gives high points in the development of electric power. *How Man Put Electricity to Work* outlines discoveries of scientists Alessandro Volta, Hans Christian Oersted, and Michael Faraday to show how man has learned to release electrical energy through chemicals, magnets, generators. Check No. 1201.

The Cell will give biology and chemistry students valuable information on the history of and current research efforts in cytology. This 44-page publication sponsored by The Upjohn Company contains photomicrographs and electron micrographs of human, animal, and plant cells and drawings of models of cell membrane and nucleus and cytoplasmic components. Also included: "Development of the Cell Concept," a chart giving chronological listing (with scientists responsible) of discoveries in this field. Check No. 1202.

Should You Be an Electronic Engineer? gives straightforward advice by Dr. Mervin J. Kelly: i.e., when *not* to specialize, requisite aptitudes, personal drawbacks. Published by New York Life Insurance Company. Check No. 1203.

Check your choice, clip coupon, and mail to: **Yours for the Asking, Science World, 575 Madison Avenue, New York 22, N. Y.**

☐ **1201 How Man Put Electricity to Work** ☐ **1202 The Cell**

☐ **1203 Should You Be an Electronic Engineer?**

See also: page 2

NAME ______________________

ADDRESS ______________________

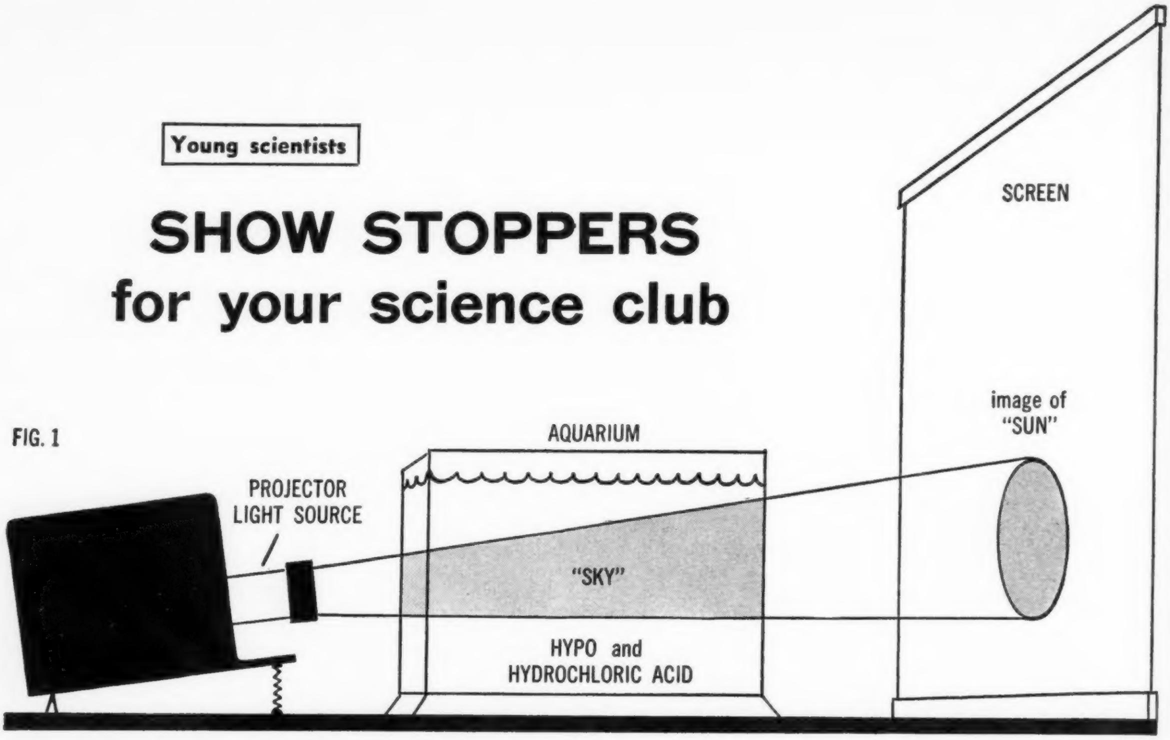
CITY ____________ **ZONE** ______ **STATE** ____________

PLEASE PRINT

Young scientists

SHOW STOPPERS for your science club

FIG. 1



Homemade sunsets

Why is the sky blue? Why does the sun appear red at sunset? These questions are frequently asked but are rarely answered satisfactorily. The answers to both questions lie in the way in which sunlight is scattered by our atmosphere.

White light, as you probably know, is composed of the proper balance of colors. These range in wave length from the long waves of red light to the short waves of violet and blue light. As the white light from the sun enters our atmosphere, the shorter waves in the sunlight (the blue and violet) strike particles of dust, water, or even air molecules and are reflected sidewise. The longer waves, however, are less likely to strike and be reflected from these particles. As a result, they readily reach the lower layers of the atmosphere. Because of the scattering of the blue and violet light, the light that reaches our eyes directly from the sun is light that has been deprived of some of its violet and blue colors. Thus, the light may have a decidedly reddish tint. On the other hand, the blue and violet light continues to be scattered and is then reflected by air particles down to our eyes. Hence, the sky assumes a blue color.

At dawn and at sunset we are looking at the sun through a greater thickness of atmosphere than at noon. This means the light must go through more particles. These scatter most of the short-wave light. As a result, the sky at dawn and at sunset is decidedly blue, and the sun looks extremely red.

This phenomenon of scattering was studied by Lord Rayleigh. He proved that the blue color of the sky is due to a large extent to the scattering of light by molecules as well as by dust particles. He showed, too, that selective scattering (or, as it is more frequently called, Rayleigh scattering) did not occur when the particles exceeded a certain critical size. Such larger particles reflected and scattered all colors and therefore appeared white. You can see this for yourself if you watch a cigarette smoker. Smoke rising from the end of the cigarette is blue. But smoke exhaled by the smoker is white. In the first case, the smoke particles are so small that they scatter mostly blue light, much as the particles in the sky do. In the mouth, however, they collect moisture and become much larger.

You can reproduce the entire sequence of a sunset in a most spectacular demonstration. Set up apparatus as shown in Fig. 1. Use a lantern-slide projector or an arc projector as the "sun." A two-gallon aquarium can represent the atmosphere. Adjust the lens of the projector so that a parallel beam of light shines directly through the aquarium to form a circle of light on a screen. The circle of light should be visible to the audience. Fill the aquarium with water at a temperature of about 20°C. Dissolve one pound of pure hypo (also known as sodium thiosulfate) in the water. Stir until the salt is completely dissolved and the solution is clear.

You are now ready to perform the experiment. Darken the room, and turn on the projector. The clear solution will scatter very little light. So the beam will be scarcely visible as it goes through the solution. And the observer's view of the "sun," as shown on the screen, will be white or perhaps yellow.

Now stir into the solution several drops of concentrated hydrochloric acid. In about a minute, colloidal sulfur will begin to form in the solution. The size of the particles will be just about right to cause Rayleigh scattering. The beam passing through the liquid will look bright blue. The image of the "sun" will begin to look decidedly yellow. The number and size of the scattering particles will increase with time. In from two to five minutes, depending on temperature, the beam going through the aquarium will take on a leaden hue. At the same time, the image on the screen, lacking the short-wave portion of the spectrum, will become a deep red. In a little while, even the red light will no longer be transmitted. The "sunset" will be over.

Unpredictable spool

Place a large spool on a table top. The kind of spool that wire or adhesive tape comes on will be fine. Have a string wrapped around the spool's center spindle so that the string comes off the bottom of the cylinder as the spool rolls along the table. Ask your club members which way the spool will roll if the string is pulled gently. Few, if any, will guess correctly. It all depends on the angle at which the string is pulled. The spool may be made to roll in either direction by making the line of pull on the string cut the table in front or in back of the line of contact of the spool with the table (see Fig. 2).

Can you explain why the spool behaves as it does? Put the question to club members.

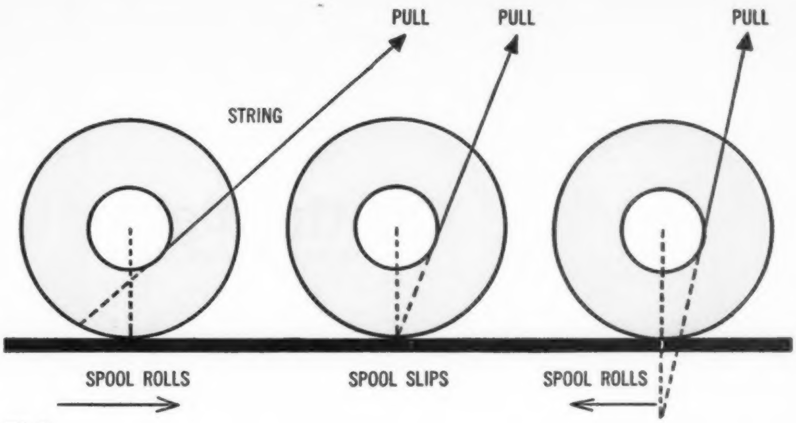


FIG. 2

Simple paper chromatography

Paper chromatography is a new scientific tool for separating and identifying compounds. Each compound in a mixture of compounds spreads out at a different rate on an absorbent paper. Here is a simple demonstration that you can use to introduce your club members to this technique.

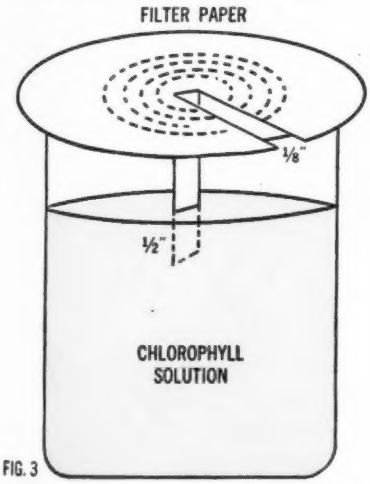


FIG. 3

There is a wide variety of materials you can use to illustrate the principle of paper chromatography. Once you have mastered the technique, you can experiment with other materials. But, for a starter, use a solution of chlorophyll, which you have extracted from green plants in the usual way (your chemistry or biology teacher can tell you how). You can get a solution rather rapidly if you grind about 10 grams of spinach leaves into 25 cc. of acetone.

Pour the solution of chlorophyll into a small beaker. For chromatographic paper, use a disk of filter paper about 3 or 4 inches in diameter. Cut two parallel slits about 1/8-inch apart from the edge of the disk to the center. Bend this narrow strip downward at right angles to the circle of filter paper. Now place the disk on top of the beaker containing the chlorophyll solution so that the strip hangs into the liquid. It will then act as a wick (Fig. 3).

The various components of the chlorophyll will be drawn up the wick and onto the center of the disk. They will spread out on the disk at different rates, forming distinct, concentric circles. The outermost ring, which was made by the fastest moving molecules, is carotene. Going inward, the rings are xanthophyll 1 and 2 and chlorophyll A and B. All these are components of plant pigments. In fact, xanthophyll and carotene are responsible for the beautiful colors of the autumn countryside.

Mysterious whirling wire

Build the following simple electric motor, and see if your club members can determine its principle of operation.

Get a glass jar exactly as high as the length of a bar magnet. Paint the inside of the jar (or paste a cylinder of black paper around the jar) so that its contents are not visible. Stand the bar magnet up in the center of the jar and hold it in this position by stuffing paper between it and the inside of the jar (Fig. 4). Get a little plastic dish, that can be set on top of the jar, and fill the dish with mercury to a depth of about 3/4 inch. Connect a stiff wire to one of the terminals of a fresh dry cell. From the bared end of this wire, loosely hang a piece of bare copper wire so its tip just touches the pool of mercury. When a second wire from the dry cell is touched to the mercury, the hanging copper wire will whirl in a circle.

The magnetic field around the wire interacts with the field of the concealed bar magnet, causing the wire to be repelled in a circular orbit. If you reverse the leads, the wire will whirl in the opposite direction. How many of your club members can guess correctly what the jar contains?

— THEODORE BENJAMIN

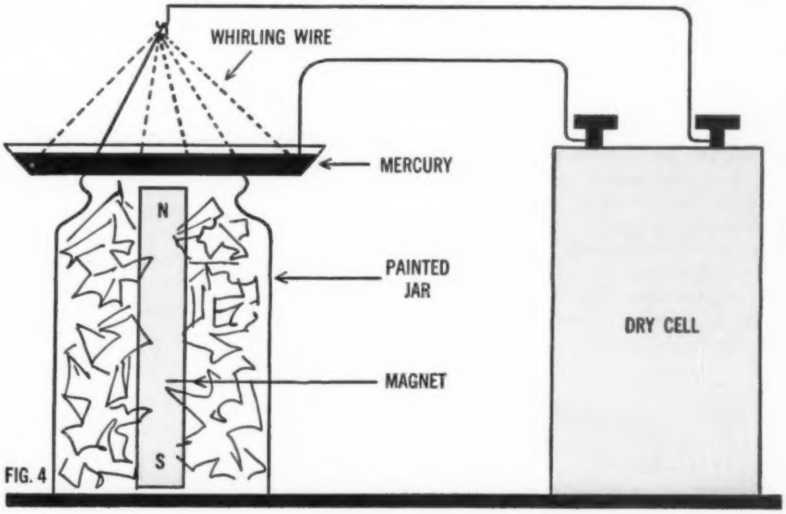


FIG. 4

On the light side

Brain teasers

Remarkable race

To test the intelligence of two boys in the neighborhood, Mr. Brown proposed the following curious bicycle race.

"Start from here," he explained, "and go once around the block. I'll give a dollar to the one whose bicycle is the *last* to get back to the starting point."

The two boys started out slowly, then each went slower and slower until finally both stopped. Suddenly one of them thought of a way to finish the race, even though both kept on trying to win. What was his scheme?

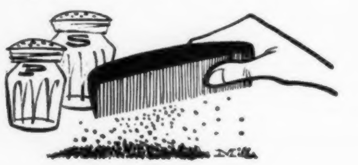
Man in the mine

If you climb to the top of a high mountain, your weight decreases a trifle. Reason: the pull of the earth's gravity weakens as you go farther from the earth's center. What happens to your weight if you descend to the bottom of a deep mine shaft?

Unpepper the salt

This is an amusing dinner-table stunt to show friends on dry winter days when static electricity is easy to produce. Shake a pile of salt on the tablecloth, flatten it with your finger, then shake some pepper on top of it. The problem is to remove the pepper from the salt.

Not many people are likely to think of the easy solution. Just put a static charge on a pocket comb by running it a few times through your hair. Bring one end of the comb to about an inch above the salt. The grains of pepper, which are lighter than salt grains, will jump to the comb.

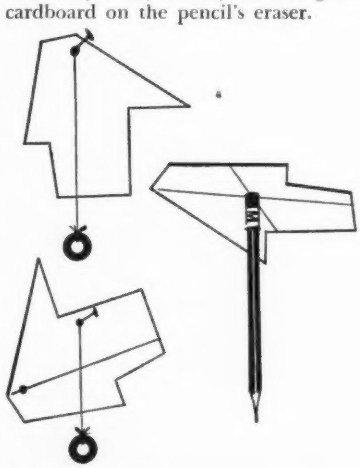


Balancing point

The center of gravity of an irregularly shaped piece of cardboard is the spot where it will balance on the eraser of a pencil. Here is an interesting way to locate this spot.

Punch a hole near the edge of the cardboard, and hang it on a nail. Make a plumb line by tying a weight to a piece of thread. Hang the thread on the nail, as shown, and mark the vertical line with a pencil. The center of gravity always seeks the lowest position it can reach, so you know it is somewhere on this vertical line.

Punch another hole at some other spot near the cardboard's edge and repeat the same procedure. The spot where the two lines cross must, of course, be the center of gravity. You can easily verify this by balancing the cardboard on the pencil's eraser.



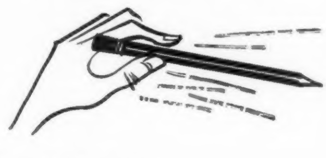
Oil and vinegar

Some friends were having a picnic. "Did you bring the oil and vinegar for our salad?" Mrs. Perkins asked her husband.

"I did indeed," replied Mr. Perkins, who happened to be a hydraulics engineer. "And to save myself the trouble of carrying two bottles, I put the oil and vinegar in the same bottle."

"How stupid of you," snorted Mrs. Perkins. "I happen to like a lot of oil and very little vinegar, but Marie likes a lot of . . ."

"Not stupid at all, my dear," interrupted Mr. Perkins. He then proceeded to pour, from the single bottle, exactly the right proportions of oil and vinegar that each person wanted. Can you guess how he managed it?



Pencil illusions

An astonishing sensory illusion can be produced with a pencil. Hold it between your thumb and first finger, near one end as shown. Then move the hand straight up and down in short, quick shakes, covering a distance of no more than two inches. Don't try to wiggle the pencil with your thumb and finger. Just hold it in a loose grip so it wobbles slightly as your hand goes up and down. If this is done properly, the pencil will look exactly as though it were made of soft rubber that bends with every shake.

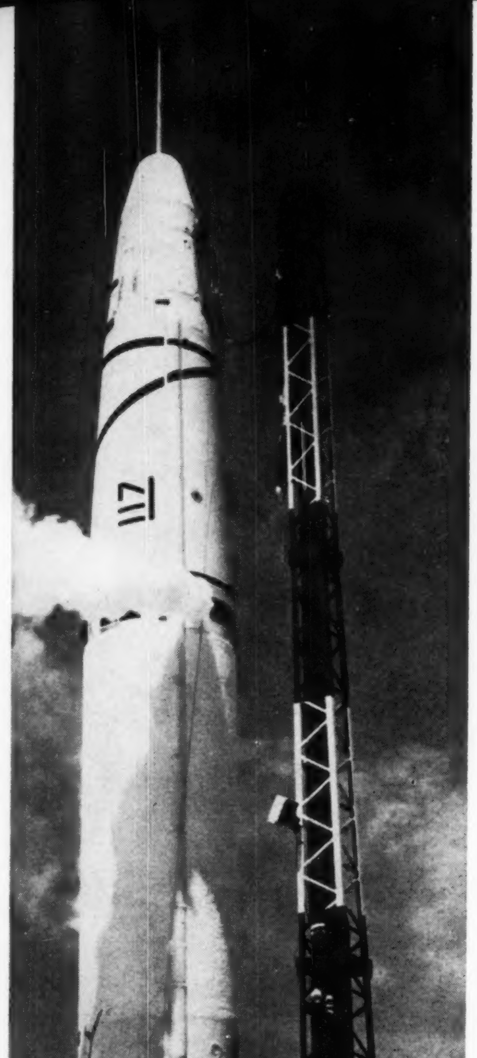
— George Groth

Answers

THE REMARKABLE RACE: The boys simply changed bicycles, then raced to the finish line.

MAN IN THE MINE: Your weight is less in the mine than on the surface, because there is less of the earth below you and a portion of the earth above. The downward pull of gravity, therefore, has lessened. At the earth's center an object weighs nothing at all.

OIL AND VINEGAR: The oil, being lighter, floated on top of the vinegar. To pour it, Perkins tipped the bottle gently. For the vinegar, he corked the bottle, turned it upside down, then uncorked it just enough to let the vinegar dribble out.



Lox fumes billow from vents of Thor missile after tanks have been topped off before firing. Thor is basic power plant of the Thor-Able moon rocket.

By Jules Bergman

Countdown at Cape Canaveral

A reporter's eyewitness account

of the tension and drama of an attempted moon shot

■ In the lonely heart of the night, while most of America sleeps, Cape Canaveral comes alive with a raw brightness all its own. It is a world unto itself, deliberately set aside from the rest of the country for security and safety reasons. Here, in the damp, clinging heat, scientists are challenging the barriers of space.

The Cape is part of the Air Force Missile Test Center, a sprawling 15,-000-acre reservation. AFMTC runs a 5,000-mile missile range, with island stations in the Atlantic, airfields, and its own fleet — a half-billion-dollar investment.

Despite security precautions, it's impossible to keep a "shoot" secret. There are 19,000 workers on the Cape, and newsmen are always pressing for a story. Most of the shoots come off at night (for astronomical or weather reasons, depending on the type of "bird" going up). And the brilliant spotlights on the hundred-foot-high gantry cranes, which cradle the rockets before launching, are visible from the beaches of the city of Cocoa, miles away.

The Pentagon, aware of the futility of barring newsmen, admits them to

Stranger than fiction

a point on the Cape itself. From the roof of Telemetry 3, a tracking station, they can watch the blast-offs.

But the drama really begins long before the blast-off. On the afternoon before the shot, newsmen are briefed at nearby Patrick Air Force Base by scientists and military spokesmen. They are told to report back to the base at 4:30 A.M. Firing time has been set for 5:45 A.M.

The countdown gets under way in the evening. It may run from seven to eleven hours, depending on the number of holds. During these delays, technical problems will be solved and defects corrected.

The Thor blockhouse and Central Control, which takes over after the blast-off, are already manned. The Test Director has started down the long countdown check list containing hundreds of separate items. His fifty-odd engineers and blockhouse personnel are in place. They've been given their weather clearance — the cloud ceiling is high enough for tracking and monitoring purposes. The area has been sealed for security; the base radars track all ships and planes in the area; fire-fighting personnel are alerted; crashboats are launched to pick up any missile fragments that might fall into the ocean; food and coffee have been brought to the blockhouse; and pad technicians have arrived in their mobile vans.

The spotlights come on, lighting the pad and gantry area as brightly as New York City's Times Square. The gantry, with enough floors to reach all areas of the Thor-Able rocket, crawls with workers. They are sealing hatches, checking valves and instruments. They ride up and down on elevators, checking, cross-checking, reporting by throat microphones to the blockhouse, getting back orders on their headsets.

It all looks confused and disorganized. But each step moves with a logical precision, as the bird is checked out and as different phases of its instrumentation are made ready. Midnight ticks by unnoticed, except by the Test Director. His big clocks are mounted next to the closed-circuit TV monitors, which bring him a close-up view of the bird. Trained engineers at periscopes inside the blockhouse watch silently, looking for any sign of trouble.

Suddenly it is 1:00 A.M., and the phone rings. It is Base Weather. All clear. The Test Director glances at his clocks again, measuring the actual time against the hold time on a separate clock. He weighs them both against the firing time. His figures jibe. The hold time (figured in the estimated countdown time to allow for delays) will allow him to meet his firing time. The shoot is on.

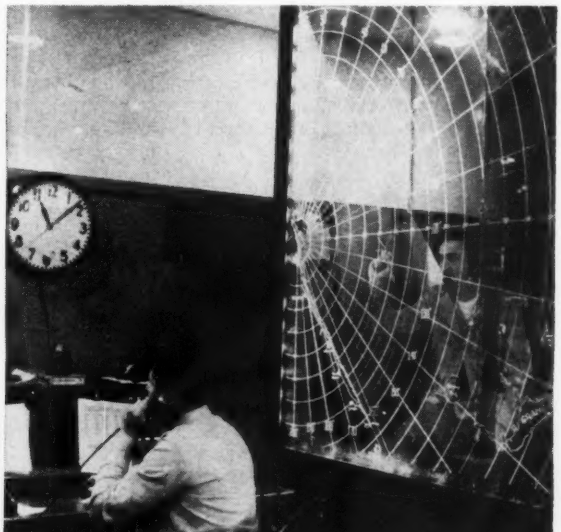
At 3:30 A.M., alarm clocks borrowed from motel owners awaken newsmen. They drag themselves down to Patrick to be loaded onto buses. It is still the heart of the night. The buses grind north on Highway A1A toward the Cape, passing darkened motels, small homes, and trailers.

At the Range entrance, Pan American Airways police (Pan Am is in charge of the police and housekeeping functions of the Cape) swing aboard, checking security badges. On the Cape itself, the faintest hint of dawn trickles through the sky.

Bunkers packed wi.h highly volatile missile fuel loom in the darkness. The LOX (liquid oxygen) plant, where the basic oxidizer for most present-day missiles is made, sweeps by. Then come the hangars and test facilities of the missile-makers. The radars silently crank away, and the radio tracking

— Official U.S. Air Force photos

AFTER THOR-ABLE IS FIRED, it is tracked by a huge (60 feet in diameter) rotating antenna (*facing page*). Periscope watcher (*inset, facing page*) is a skilled engineer who monitors every last tense step of pre-firing operation, searching to find trouble before blast-off. A word spoken into his lip microphone will scrub a firing. Earlier in the countdown, the engineers and technicians in the blockhouse (*below, left*) go through the checkout. Every movement at the launch pad is accounted for by four TV cameras, every second by four clocks. At Central Control (*below, right*), positions of ships and planes are plotted so that a bird gone wild can be blown up before endangering them.



towers loom, like faintly-lighted swords, above the flat-duned sand. Then the lighted Thor-Able gantry comes into view — the giant Atlas and Titan gantries and all the other launch pads are darkened.

The buses stop, and the newsmen climb to the roof of Telemetry 3. It is 5:15 A.M. There is only the faintest suggestion of daylight, but already the heat and dampness make activity unpleasant.

TV and newsreel cameras are set up, telephone and radio circuits checked. The loud-speakers, hooked into the control blockhouse, come on. The voice of the Countdown Controller intones, "T minus 14 and counting." The count is read off every minute until T minus 2, when it is speeded up to once every 15 seconds.

The Thor-Able, swathed in light, stands out against the growing backlight of the dawn. It has black circular stripes so it will stand out better in photographs. The fuel hoses are hooked in, and LOX fumes vent from the overflow ports. The umbilical cord, supplying the pre-launch power, is plugged into the missile's upper structure.

The gantry crane rolls back on its rail tracks, leaving the Thor-Able standing alone on its pad. They can still stop the launching. But unless a major technical problem crops up, the bird is going to go.

"T minus 4," the Controller drones. So gradually that no one has noticed, the sun has crept out. Waves of heat bounce off the roof of Telemetry 3.

Pace picks up

Tension mounts as the operation begins to move more swiftly. The Controller calls a hold, which lasts several minutes. Hopes begin to die. Maybe they'll have to scrub the firing. The timing has to be exact: the bird must be fired within the fifteen-minute period when the moon is closest to the earth. After that, the chances of placing the instrument package in a lunar orbit are gone. They can scrub today and scrub tomorrow, but after the third day another month must go by before the moon and the earth are again in the position for a firing.

Almost undetected amid the groans, the Controller calls out, "T minus 3 and counting" — the hold is over, the "bug" corrected. He swiftly calls out final items on the check list. "T minus 2 and counting." The radio lines are opened, wire-service circuits are cleared, TV cameras flick on, newsreel cameras begin to grind.

In the control blockhouse, few words are spoken. All eyes — except those at the periscopes, watching for any slight hint of trouble — are focused on the TV monitors. The shoot can still be stopped. A million-dollar missile can be saved, if the trouble can be found and corrected ahead of time.

In Central Control, Air Force personnel scan their radars, monitor their own TV picture of the launch pad. The Range Safety Officer calmly hovers over his radar plot board, looking for intruding aircraft or vessels. At his finger tips, the destruct button is now lighted. If the bird goes wild, he has only to press the button. It is his decision and his alone, but he cannot waver. Lives can be lost if he doesn't press the button swiftly enough, igniting a destructive charge and blowing up the bird before it can hit homes on the Cape. The generals and the brass from Washington maneuver nervously in a glassed-in booth just back of the main plot board, watching the unfolding of the last few moments.

Sirens sound on the pad now, clearing all personnel. The base fire trucks, their engines running, sit ready.

Automation takes over

In the blockhouse, the Test Director presses another button. Automation takes over. From here on in, the firing is handled by an automatic sequencer, executing the scores of last-minute functions and orders far more swiftly and efficiently than men could.

The Test Director's hand rests near two final buttons — his last ways of stopping the bird if trouble develops. One controls the hold-down gates, vise-like steel arms that grip the bird until released. The other is an over-ride button that cuts off the sequencer and stops all electrical input into the bird, halting the launch.

"T minus 30 and counting." From Telemetry 3, the newsmen watch tensely as the huge fuel hoses begin to drop away from the Thor-Able. Only the umbilical cord still seems to hold the bird to earth. Plumes of LOX rise, as the tanks are topped off. LOX evaporates so rapidly that the fuel must continually be pumped in until the last few seconds before firing.

"T minus 15 . . 14 . . . 13 . . . 12 . . ." No one speaks now. Hundreds of eyes are focused on the bird in the agonizing tenseness of these final seconds. The umbilical has fallen off; the Thor-Able is now almost free of its earthly bonds.

"T minus 8 . . . 7 . . . 6 . . . 5 . . . 4 . . . 3 . . . 2 . . . 1 . . . Ignition." For a split second, nothing seems to happen. Then a torrent of flames belches forth from the rocket's exhaust. The bird vibrates and rocks back and forth hesitantly, until the exhaust builds in intensity to the point where there is enough thrust for lift-off. Seconds pass — just a few seconds — as the Controller keeps counting, "T plus 3 . . . 4 . . . 5 . . ." Then, very swiftly, the Thor-Able leaps away, pointing straight up. The roar of its engines sounds like a score of trains rushing by on all sides.

Voices all around call out, "A beautiful launch . . . look, she's rising straight up!" The bird passes through a cloud layer at 10,000 feet, arcing ever so slightly over toward the southeast. It looks like a perfect launch.

Inside the blockhouse, the scientists and engineers hungrily watch the monitors as their bird roars upward, hoping silently that nothing will go wrong. The chances of reaching the moon and going into an orbit around it are slim indeed — 1 in 25, perhaps. But there is no chance at all if the slightest mechanical malfunction occurs.

"T plus 12," the Controller calls out and ceases counting. Field glasses track the Thor-Able easily. As it arches upward, it leaves a brilliant white contrail in the hot Florida sky. It is almost gone now. From every indication, the shot looks good. Then, at 50,000 feet, a burst of white smoke shoots out from the Thor-Able. Almost no one is able to see it on Telemetry 3. But in the blockhouses, the powerful tracking cameras and scopes pick it up instantly. The bird has blown up in mid-air.

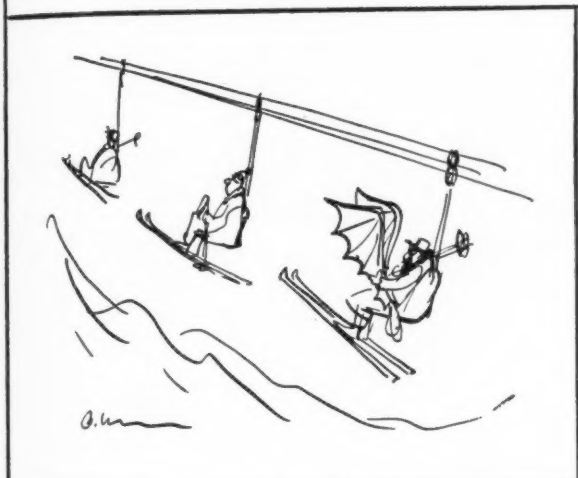
The big question

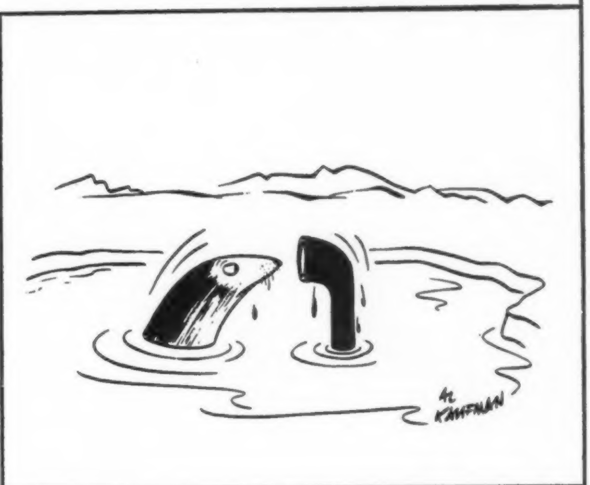
On Telemetry 3, there is still optimism as the newsmen wait for the official word. Fifteen minutes later, it comes in the form of a mimeographed handout from the Air Force. The bird has blown up. Unexplained technical troubles. Later, after all the tracking and telemetric data is run through the processing machines, the flaw is discovered: the main-stage engine of the Thor went haywire — there was a sudden pressure build-up, ending in an explosion.

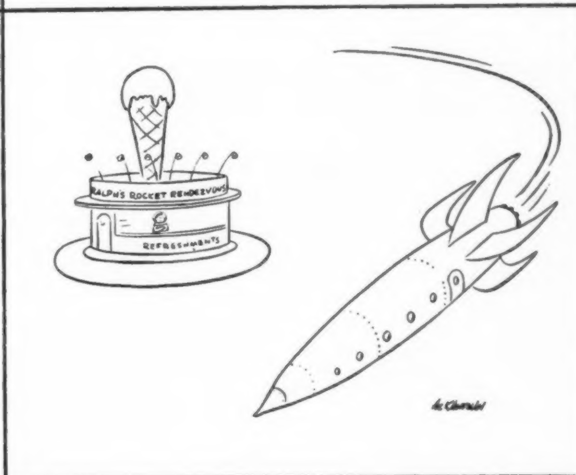
It is all over before the day has really begun. It is not yet 6:30 A.M. Everyone is at once exhausted and depressed. No one says much, but the failure shows in their eyes, in the way they walk, and in the things left unsaid. Only the scientists do not appear depressed — they are merely disappointed over a temporary setback.

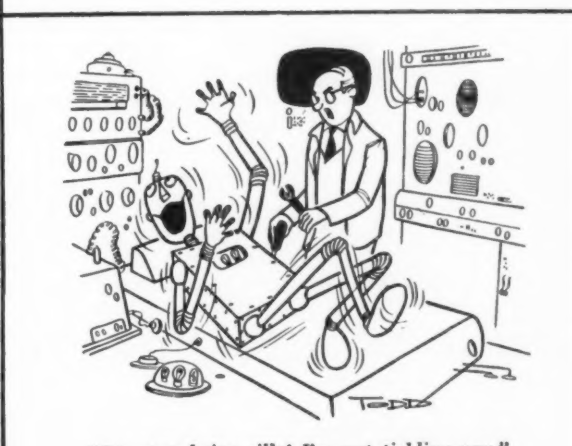
High above, the moon, frustratingly elusive, still hangs in a corner of the sun-drenched Florida sky. This gravitational prisoner of the earth is, at least for the moment, still beyond the earth's reach. The countdown has ended. But the challenge is only beginning.

Jest for fun









"Oh, stop being silly! I'm not tickling you."

How to do it

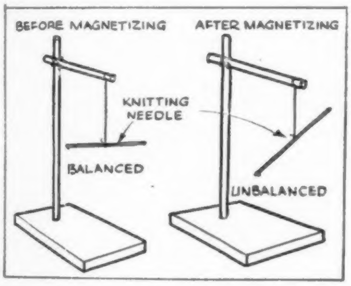
Simple dipping needle

Balance a steel knitting needle from a thread tied to a wooden dowel support, as in Fig. 1. Magnetize the needle by stroking it with a permanent magnet, being careful not to shift the position of the thread-needle junction. One end of the needle will now dip — the needle will be out of balance. It will line up with the dip angle of the earth's magnetic field for your location.

You may find it easier to put a drop of quick-drying plastic cement or model-airplane cement on the thread and needle junction. When the cement dries, it will hold the needle so that the balance point will not shift during magnetizing.

— Drawings courtesy of Popular Science

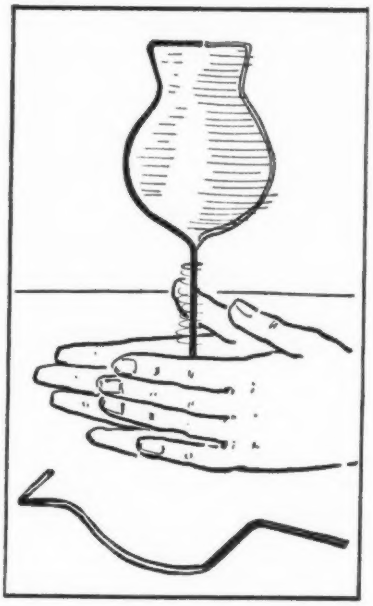
Fig. 1



Persistence of vision

The usual way of demonstrating persistence of vision is with the well known bird-in-the-cage device. A simpler device can be made from a piece of coat-hanger wire bent to the shape shown below the hands in Fig. 2. Simply hold the straight section between the palms of your hands and move the hands back and forth slightly to rotate the device. When the wire is spinning at the rate of at least sixteen rotations a second, students will see the outline of a goblet. The reason, of course, is that an image persists on the retina of the human eye for 1/16 of a second.

Fig. 2



Other interesting shapes may be produced in a similar manner. You can point out that motion pictures also depend upon the persistence of vision to give the illusion of motion. If students examine motion picture film, they will see that it is a collection of still pictures. When the film is projected, one picture persists until the next is seen. Each tiny variation in individual pictures results in an illusion of motion. Silent movies are shown at 16 frames per second, whereas sound movies are shown at 24 frames a second.

A simple demonstration of heat conduction

Place a glass funnel (do not use a plastic one) into the top opening of a Bunsen burner. Over the top of the funnel, as in Fig. 3, place some wire gauze or metal window screening. Turn on the gas, and ignite it just above the gauze. The gas will burn above the gauze, but there will be no burning inside the funnel, as anyone can see. Reason: the wire gauze conducts the heat of the flame away from the gas and air in the funnel below. Thus, there is no ignition at that point.

This is the principle of the Davy safety lamp, used in mines. In that lamp, the burning light source is inside a tube of wire gauze. It cannot ignite gas that might be present in a mine, because the screening conducts the heat away.

Fig. 3

Shop talk

Science news items are the subject of a recent "Shop Talk" contribution from Miriam L. West of Charleston (W. Va.) High School. She writes:

One of the standing assignments in our chemistry classes is a news item due each week. These come from newspapers, popular magazines, technical bulletins, chemical or engineering journals. To insure some thought about each clipping, the student involved writes a brief comment on the notebook-size paper on which it is mounted. After the sheets are checked and returned, they are filed in the chemistry notebook for future use.

The purposes of this assignment are fourfold for the student:

1. Students are kept alert to and interested in current happenings in science, as well as becoming familiar with the names and work of living scientists.

2. Even the poorer students can complete this assignment.

3. An item dealing with topics we have studied or will be studying makes chemistry a *real* rather than a textbook subject. Timely items are shared immediately with the whole class. Others from the students' "file" are shared later, when they deal with the topic under discussion.

4. Bulletin-board displays are developed for each topic we study. These items furnish a source of readily available motivating material. One of our best on living scientists had a fine article about Niels Bohr. Students met a "friend" when they learned later about Bohr's work.

At the end of a nine-week experimental period, we voted in each class on whether to discontinue or to keep the news-item assignment. Each class voted almost unanimously to continue.

The outcomes suggested above are all for the student. For "shop talk" with other teachers, I should like to point out the value of this for the teacher. The students ferret out articles of extreme interest from sources to which we do not have ready access. The majority will be familiar articles from the daily paper, but some real treasures will be in the collection each week.

TEACHER'S TOOLS

MINNEAPOLIS-HONEYWELL, Brown Instruments Division, presents the recently developed Brown ElectroniK Null Indicator. This new instrument is the first radical departure in these conventional instruments with their inherent limitations and disadvantages. Unaffected by vibration and requiring no special mounting or leveling, the new null-balance type of indicator saves valuable laboratory time. The new Brown achievement provides the fastest possible method for resistance and potential measurement through the use of precision-type manual-balance potentiometers and Wheatstone bridges. The ElectroniK is useful in numerous other instances where a galvanometer is required. *(For a data sheet, check No. 120A.)*

ARTHUR S. LAPINE AND COMPANY brings the third dimension to carbon-chemistry teaching with a comprehensive line of LaPine-Leybold colorful atom models. The atom models (according to Stuart and Briegleb) actually correspond to the mean of the experimentally measured values for the atoms and provide ideal demonstration and advanced student participation. The models are available in an attractive storage cabinet holding five white polystyrene trays storing at least 195 models. Easily assembled and disassembled, the models feature snap fasteners and hooks, with provision for poly-bondings. Classroom experience has proved these atom models highly worth while for teaching concepts of isomerism and other third-dimensional theories of carbon chemistry. *(For complete information on the atom models, check No. 120B.)*

TAYLOR INSTRUMENT COMPANIES make classroom weather study interesting and easy for teacher and student. Whether it's a recording hygrometer, maximum-minimum thermometer, or high-speed anemometer, Taylor's line of precision weather-indicating instruments will heighten interest and greatly enliven classroom study and discussion of weather throughout the school year. Ideal for student long-term projects and class reports, their Thermograph Recorder (No. 2350) provides a seven-day record of temperatures. The Weather-Hawk Recording Barometer (No. 2316) features an electric clock drive. *(For full information, check No. 120C.)*

Check your choices, clip this coupon, and mail to
Science Teacher's World, Dept. TT
575 Madison Ave., New York 22, N. Y.

☐ **120A** ☐ **120B** ☐ **120C**

NAME ______________________

SCHOOL ______________________

ADDRESS ______________________

CITY ______________ **ZONE** ______ **STATE** ______

PLEASE PRINT

Modern references and textbook 'tools'

The Office of Education, Department of Health, Education and Welfare, offers a veritable storehouse of valuable and interesting publications suited to practically all of your teaching problems and needs. Books, pamphlets, and brochures are inexpensive, too. Many are free. Listed below is just a sampling of printed materials available through your Government:

Education for the Talented in Mathematics and Science, by K. E. Brown and P. G. Johnson, 1953. "A report of special importance today in view of the need for those with specialized training in science and mathematics."

Analysis of Research in the Teaching of Science (July 1955-*July* 1956), by Ellsworth S. Obourn, Specialist for Science, 1958. "Highlights and reports special studies on elementary, secondary and college level."

Science Teaching in Rural and Small Town Schools. "A bulletin useful in pointing out how the resources in the immediate environment of small schools may be helpful to teachers who want to improve their science teaching."

Write for complete information on these and hundreds of other helpful publications to: Office of Education, Dept. of Health, Education and Welfare, Washington, D.C.

AO Reports on Teaching with the Microscope

Exposing the Embryo . . . or if not the answer, at least an insight into the old question of which came first, the chicken or the egg

Our experiment won't give your students the answer to which came first, the chicken or the egg, but it may give you some idea as to the unique potential the stereoscopic microscope provides for truly creative science teaching. You can use it to stretch your students' minds to 3-dimensional microscopic worlds beyond the ken of their every day experiences.

It's no coincidence, of course, that AO has an excellent stereoscopic microscope to offer. Perhaps you already know about our new line of Cycloptic stereoscopic microscopes. More and more of them are going into High Schools, Junior Colleges and Colleges. Science teachers like their dependable performance and almost indestructible ruggedness. School administrators like their low cost . . . you can purchase model 56F-1 for $189.50 each, in quantities of 5 or more!

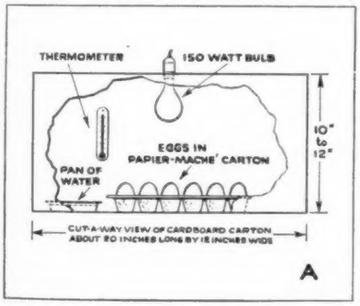
If you have Cycloptics we invite you to try this classroom tested experiment. If not, you may want information about the instrument. We'll be glad to send you our 32 page color brochure. Just write to American Optical Company, Instrument Division, Dept. M252, Buffalo 15, New York and ask for Brochure SB56.

EXPERIMENT

Studying the growth of a living chick embryo

MATERIALS AND PREPARATIONS

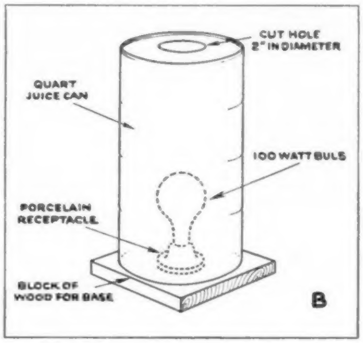
1. Supply of fertilized chicken eggs — preferably 24 hour chick embryos. These can be obtained inexpensively from any hatchery.



2. Incubator: (See diagram). Optimal temperatures are 90° - 110° F. Place small pan of water in incubator for proper humidity (about 60%).

3. Egg Candler: (See diagram B). To candle simply place egg over hole. (Candle in darkened room).

4. Set up Cycloptic Microscope. Melt paraffin and keep hot. Cut "nest" from papier mache' egg carton. Have sharpened steel needle, tweezers, wide mouth medicine dropper, sharp manicure scissors, small brush and clean cover glass ready at hand.

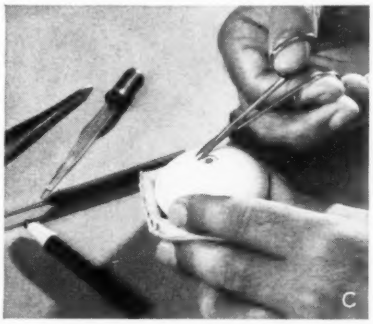


PROCEDURE

1. Select 2 - 4 day old egg. Candle egg to locate position of embryo. This will appear as a shadowy network of blood vessels (area vasculosa) radiating from an indistinct dark spot, which is the embryo.

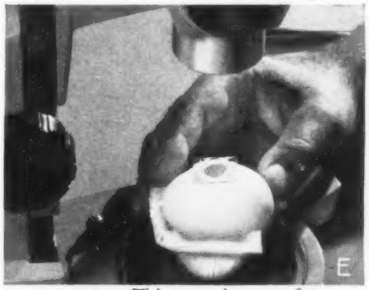
2. Mark position of embryo on shell with grease pencil . . . do not rotate or roll egg since embryo may shift. Place egg in nest with embryo up.

3. Cut window about size of dime over embryo. Start by carefully picking with needle until small hole is made. Then insert point of manicure scissors into hole and cut (see photo C). Use tweezers to remove pieces of shell. Very carefully puncture egg membrane (immediately under shell) and remove with tweezers. Embryo should now be exposed on top of yolk. Remove excess albumen, if necessary, with medicine dropper.



4. Seal cover glass in following way: with camel hair brush apply melted paraffin to the edges of the window. Gently place cover glass over the window. Seal edges with paraffin. (See photo D).

5. Place egg under Cycloptic Microscope for study. (See photo E). Chick embryo will remain alive for many days and its nervous and circulatory systems can be observed and wing and leg buds can be detected in various stages of embryonic development. Keep egg incubated between observations. Use of sterile technique (wash instruments in 70% alcohol, rinse in sterile .9% saline solution) will keep the embryo alive for a longer period.



OBJECTIVES: This experiment, of course does not attempt to impart a fund of knowledge concerning embryology. However, it lends itself ideally to the achievement of many basic science teaching objectives; i. e., the principles of reproduction and heredity; instrumental and manipulatory skill; appreciations of the work of scientists and the scientific method. And finally, because this experiment has been actually used in classrooms, we know it creates an interest in the broad field of science.

SCIENCE TEACHERS! $25 For Your Experiment

Here's a chance to share your ideas with other teachers. We will pay $25.00 for each experiment involving either laboratory or stereoscopic microscopes accepted by us for future ads like this one. We're looking for unusual experiments suitable for the high school and junior college level. Don't worry about the form, or illustrations, just give us all the pertinent information. In the event of similar experiments the one bearing the earliest post-mark will be used. See your name in print . . . write in now!

American Optical Company

Instrument Division • Buffalo 15, New York

Science World Index

Vol. 4, 1-8 • Sept. 25, 1958 — Jan. 20, 1959

Following abbreviations are used: S-September; O-October; N-November; D-December; J-January. Major articles are indicated by an asterisk. Articles from SW departments are keyed as follows: (C), Careers; (N) Science in the news; (SF), Science fiction; (STF), Stranger than fiction; (YS) Young scientists. Date of issue is followed by page number — N11:6 (November 11 issue, page 6). Index does not include News department for Jan. 20.

S25:18;
*Plants
sium vs.
lends a
N11:10;
ed words,

; *Traits

31; N11:
9

y): Anti-
shes (N),
8; Potas-
Radiation
ioactivity

, N11:12
3:18
, S25:16;
18; Army
oon shot
e Canav-
iners de-
et opens
cket and
siles, and
nterplan-

n, N11:4

lite (N),
N25:18;
S25:13;
O14:4
er, S25:4
fiction):
nder and
8:25

12
ctive (N),

; II, D9:
pace (N),
D23:16;
of space),
N25:18;
Six steps

N25:4
ent howl-
); Count-

r eclipse

J20:8

y, O28:8

S25:10

S25:17;

, S25:4;
*Science

x): *End
eads the

triot sci-
t atomic
lchemist,

ers (STF)

ite orbit,
Culturing
uit flies,
O14:22;
for anti-
N11:18;
roponics,
0; Meas-
on's first
O28:20;
launcher,
rmoelec-